DOCUMENT RESUME

ED 198 626 EA 013 185

AUTHOR Steer, Donald R., Ed.
TITLE The Emerging Adolescent: Characteristics and Educational Implications.
INSTITUTION National Middle School Association, Fairborn, Ohio.
PUB DATE 80
NOTE 64p.: Based on presentations at the Institute on the Emerging Adolescent (Greeley, CO, July 9-13, 1979). Graphs may be marginally legible due to small print of original document.
AVAILABLE FROM National Middle School Assn., P.O. Box 968, Fairborn, OH 45324 ($2.95; quantity discounts).

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Adolescent Development; *Adolescents; *Cognitive Development; Cognitive Processes; Developmental Stages; *Education; Intermediate Grades; Junior High Schools; Learning Readiness; *Middle Schools; *Physical Development; *Student Needs
IDENTIFIERS Piaget (Jean); *Preadolescents

ABSTRACT

Nine articles on the young adolescent consider the ability of middle schools to adapt to the needs of their students, the educational implications of preadolescent development, adolescent brain growth and cognitive ability, and the relevance of Piaget's psychology to the middle school. The authors' conclusions include the necessity to identify and investigate the developmental needs and learning capacities of emerging adolescents, to nurture creative problem-solving abilities, to regroup middle school students according to growth and maturation characteristics rather than age (developmental grouping), to introduce concrete rather than abstract concepts to complement brain growth periodization, and to provide for discovery learning. (Author/WD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED198626

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

THE EMERGING ADOLESCENT
CHARACTERISTICS AND EDUCATIONAL IMPLICATIONS

Edited By
Donald R. Steer
Chair, NMSA Publications Committee

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

H. D. Gaddis

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

EA 013 185

NATIONAL middle school ASSOCIATION

Copyright 1980 by National Middle School Association, P.O. Box 968, Fairborn, Ohio 45324.

$2.95

Foreword

What is a middle school? The middle school concept can concisely be defined as:

"a *unique* educational environment created to meet the *unique* needs and characteristics of the emerging adolescent."

This might seem to be an oversimplification when describing the many complexities of the emerging adolescent. It might seem even more simplistic when one attempts to define their needs and characteristics in terms of educational programs. However, I believe such a definition goes to the very heart of the middle school movement.

In order to accept such a concept, one must accept the following two premises that are basic to its definition:

1. The emerging adolescent is indeed unique.
2. In order to effectively educate this particular age level, an educational environment must be created that is different from the senior high or elementary school.

The question then becomes, what type of educational programs work best for this age level? This question might seem a bit premature when one considers that the uniquenesses of this age level have not as yet been well defined. I am convinced that we have tended to ignore the fact that the ages from ten to fourteen mark a distinct developmental stage in a child's life. We can no longer think of this period of development as just a part of the larger entity called "adolescence."

With the onset of puberty (occurring earlier), and the passage into adulthood (occurring later—sometimes encompassing 10-12 years), we must take a more refined look at this whole period called "adolescence."

The middle school movement has grown as a result of our increasing knowledge of the emotional, physical, and cognitive needs and characteristics of this age level. Conversely, the middle school movement has stimulated a renewed look at this age level as a distinct developmental stage. A better understanding of the emerging adolescent is certainly a prerequisite to creating a good middle school. At the same time, it can also be a result of the creation of a good middle school.

This publication is a reminder that the middle school concept and the identity of the emerging adolescent are synonymous and interdependent.

John H. Swain, President
National Middle School Association

Preface

The Middle School Movement has progressed from infancy into its own early adolescence. The issues that confronted the early middle schools, such as grade organization and legitimacy of interscholastic sports, have been replaced by the more sophisticated issues that address the day-to-day needs of all middle school students. The middle school has come of age.

The 1979 Institute on the Emerging Adolescent was co-sponsored by the University of Northern Colorado and the National Middle School Association. The Institute was designed to first take an indepth look at the needs and characteristics of the emerging adolescent, and then to consider the development of an appropriate educational environment. In order to accomplish these tasks, nationally prominent personalities from the fields of medicine, psychology and neurological science were asked to address the Institute. Dr. Allen Drash, Dr. Hershel Thornburg, and Dr. Herman Epstein provided an excellent framework for clearly understanding the physical, social/psychological, and cognitive characteristics of the emerging adolescent. From this basic framework, Dr. Glenn Maynard, Dr. Donald Eichhorn, and Dr. Michael James, nationally prominent middle school educators, were able to establish fundamental curriculum components for middle school education.

The Institute, however, went one step further and provided participants with a variety of workshop sessions which highlighted some practical middle school programs. These included presentations by Edward and Phyllis Brazee, William Popejoy, and Rex Schweers, as well as by other in-state participants.

The papers included in this publication are based on selected presentations at the Institute. As such, they represent the views of the authors. During the Institute, a tremendous amount of sharing took place. This enhanced not only the participants' knowledge of the needs and characteristics of the emerging adolescent, but also how those needs and characteristics might be considered in a meaningful educational environment. We hope to share through this publication some of the insights which were explored at the Institute.

Edward N. Brazee and John H. Swaim
Co-directors, 1979 Institute on the Emerging Adolescent

Contents

Can the Middle School Adapt to the Needs of Its Students? 1
Hershel Thornburg

An Interactive Model: Three Theoretical Constructs Related to Preadolescent Development and their Educational Implications 8
Michael A. James

Variations in Pubertal Development and the School System: A Problem and A Challenge 15
Allan Drash, M.D.

Middle School Developmental Age Grouping: A Needed Consideration 27
Donald H. Eichhorn

Brain Growth and Cognitive Functioning 34
Herman T. Epstein

Cognitive Growth and Development of the Middlescent Learner 38
Glenn Maynard

Brain Growth and Higher Level Thinking 42
Edward N. Brazee and Phyllis E. Brazee

Piaget and Middle School Teaching 48
William D. Popejoy

Comments on a Two-dimensional View of Cognitive Ability 51
Rex R. Schweers, Jr.

Introduction

The Publications Committee of the National Middle School Association is pleased to present to its members and other interested persons this booklet on the emerging adolescent's characteristics and their implications for educational programs. All the articles are adapted from presentations at the Institute on the Emerging Adolescent held July 9-13, 1979, at Greeley, Colorado. This institute was co-sponsored by the University of Northern Colorado and the National Middle School Association. These articles have appeared in the Fall 1979 issue of the *Colorado Journal of Educational Research*. The editorial assistance of Mr. Paul Brown of University (of Michigan) Publications with this present booklet is gratefully acknowledged.

In the initial article Hershel Thornburg reviews a number of the findings regarding the emerging adolescent's social and cognitive characteristics and reminds teachers of some of these characteristics that must be taken into consideration as they plan instruction. He challenges middle school educators and researchers to identify and investigate the developmental needs and learning capacities of emerging adolescents so that the middle school might become a viable educational alternative.

Michael James then suggests a three-dimensional model that incorporates Erik Erikson's theory of ego (identity) development, Raymond Cattell's theory of fluid and crystallized intellectual abilities, and Anthony Gregorc's continua of learning styles. James presents these three theories as a basis for both educational practice and further research.

A very comprehensive discussion of factors in sexual maturation is presented by a physician, Allan Drash. He provides details regarding the hormonal control of maturation, considerable medical data regarding the relationship of physical and sexual development in normal adolescents, and the variability in such development. He also gives some attention to identification of exceptional cases requiring medical attention, and implications for educational settings.

Donald Eichhorn, well known in the middle school movement and originator of the term "transescence," argues that biological maturation is more appropriate as a basis for grouping of students within schools than the traditional chronological age criterion. His concept of developmental grouping has been in place about ten years in Upper St. Clair, Pennsylvania, and is described for the reader.

The topic of brain growth periodization has excited middle school conference-goers the past several years. Herman Epstein, the bio-physicist who has provided the major research and writing in this field, summarizes his

data and conclusions in this brief article, suggesting that new cognitive functions can be developed only during the brain's growth spurts, and that for most middle school students abstract reasoning cannot be attained before age 14.

Glenn Maynard, a former NMSA president, raises a number of questions about middle school education and calls for a consideration of Epstein's findings as answers to these questions are sought. Edward and Phyllis Brazee describe an attempt to assess the cognitive level of seventh grade students in a language and literature class, and to apply an instructional strategy appropriate for students of varying cognitive levels. William Popejoy briefly reviews Piaget's concept of mental operations, and provides recommendations for appropriate considerations in middle school teaching. Rex Schweers presents a two-dimensional model of Piagetian cognitive ability, with associated research results quite consistent with the Epstein conclusions.

This diverse collection of articles reflects current theory and thinking regarding characteristics of the emerging adolescent and implications for educational practice. It is the hope of the Publications Committee of the National Middle School Association that this volume will make the reader more aware of the complexity of the individual we variously call the transescent, middlescent, early adolescent, or emerging adolescent. May researchers be stimulated to learn more about this unique individual and his learning, and may practitioners be motivated to seriously consider these characteristics as they design and implement appropriate educational practices.

for the NMSA Publications Committee,
Don Steer, Chair

Can the Middle School Adapt to the Needs of Its Students?

Hershel Thornburg

Since 1970 when I first became interested in the middle school, indicating such by an article on the developmental tasks of this age preadolescent, it has been interesting to observe the growth and national visibility of the middle school movement. Drawing upon practitioners and professionals, one is led to believe that the viability of the middle school is rapidly becoming a reality. This is further enhanced by the emergence of focal points such as the Center for Early Adolescence at the University of North Carolina and growing interest on the part of private foundations and federal agencies in funding programs for the middle school-aged preadolescent.

While the past decade has brought a plethora of articles on the characteristics of the middle school, it has brought a dearth of articles on the characteristics of the middle school adolescent. In this respect the efforts of pre- and early adolescent advocates have been few and far between—even to the point that one wonders if the middle school is any more than an organizational innovation.

There is one quasi-philosophical statement that underlies my persuasions about the middle school student and his or her relationship to the educational process, which is, *the extent to which the middle school becomes a viable educational alternative to traditional school models is directly proportional to the ability of middle school educators and researchers to identify and investigate the developmental needs and learning capacities of the students that it serves.*

Within this article, it is impossible, even presumptuous, to think that I could explore all the ramifications of the preceding statement. However, to some extent this can be accomplished by focusing on the following three categories:

1. The nature of *human development*. What are the characteristics of preadolescents and how do they interface with the school?
2. The nature of *learner characteristics*. Just how do these preteens learn and how may their environment influence their development?
3. The nature of *teacher characteristics*. To what extent are classroom teachers aware of the developmental and learning needs of their students?

Human Development

By viewing human development as a continuous process across the life span, it is easy to see that there are no clearly demarcated events that characterize entrance into and exit from this preadolescent developmental period. The elusiveness of such well-defined characteristics may become a source of challenge or discouragement. Clearly the task is a more demanding one than isolating the characteristics of children or adolescents.

Hershel Thornburg is Professor of Educational Psychology, University of Arizona, Tucson, Arizona.

I should like to discuss some characteristics of preadolescents, hopefully in light of the contemporary educational and social environments. These characteristics exist primarily because of the ways in which they unfold developmentally, although they are impacted by the environment.

An important aspect of development is *developing friendships with others* (Thornburg, 1970). Coming off the eighth and ninth years of life, where children typically have a low need for social interaction, the gradual emergence of peers is vitally important to 10 to 15 year olds. Their curious and exploratory nature manifests itself socially as well. Peer group formations are usually initiated among friends of the same sex (Dunphy, 1963). Learning to accept and be acceptable to others is of vital importance. There is security in same-sex companionship at 10 to 12 compared to the opposite-sex companionship in later development. They have learned over the years that friends are important, and what were tentative friendships in the primary grades take on more solidarity by the middle school age.

Research is rather sketchy as to when and under what conditions preadolescents make the transition from same sex to opposite sex participation. The trend has been down from ages 14-15 to 12-13 within the past decade. This correlates with increased emphasis on physical maturation and social pressure to be involved in adolescent-like activities as a preadolescent. Studies on preteen drug use, sexual behavior, female pregnancy, runaways, and delinquency provide increasing insight into the behavioral world of the preadolescent, most of which is reciprocated by one's friends.

A second developmental characteristic is *becoming aware of increased physical changes* (Thornburg, 1970). Primarily as a result of better nutrition and general health the age of adolescent developmental maturity has moved into the preteen years. Girls begin their growth spurt around age 10; boys some 12 to 18 months later (Tanner, 1973). Both are within the traditional elementary school years.

The female begins breast development in her tenth year, experiences considerable genital growth in her eleventh year, and begins to menstruate in her twelfth year (12.8) (Hammer & Owens, 1973; Sommers, 1978). Virtually all females are experiencing menarche by 15, regardless of ethnicity or socioeconomic status (MacMahon, 1970).

Male heighth, genital growth, and involuntary erections all begin around age 12. These growth processes continue for approximately three years during which all secondary sex characteristics emerge (Tanner, 1962). Thus, while the male is less developed than his female counterpart throughout the middle school years, his maturity is comparable by 16. Anxiety often accompanies physical growth, especially given the opportunity to compare personal growth with classmates and comparing oneself to existing social stereotypes, an idea which will be explored further.

Preadolescents are expected to *learn new social/sex roles* (Thornburg, 1970). As role models become more diverse this sets up a conflict in the preteen between carefully taught traditional roles and more contemporary roles—a conflict often without resolution. This conflict exists in many families where both parents work but the reasons for their working are either unknown or have been unexplained to the preteens within the family.

There is some research that indicates adolescents have strong traditional sex-role beliefs, although the research does not indicate if this is a phenomenon that is extended from the preteen years (Thornburg, 1974a, 1979a). The social environment and economic realities make it quite evident

that men and women both are more balanced in their roles than ever before. This is characterized by increased educational levels, more career-oriented women, more political involvement, and a higher incidence of employment. Is this adult reality beyond the conceptual level of preadolescents and adolescents? Is it possible that the normal developmental process occupies the preadolescent's energies so much that this subsequent adult function is too remote or unrealistic to be learned in the middle school years? Unfortunately, I can pose such questions better than I can answer them. However, I doubt that *all* adult concepts and functions are beyond the intellectual capacity of early adolescents even if they are beyond their experiential capacity. The lack of concern among professionals may be the greatest variable with which we must contend if we are going to raise the sense of awareness in preteens to alternative and/or contemporary roles.

Many preadolescent behaviors seem to be heavily *attributed to stereotypy*. Being stereotypical is a 13-letter word—or is it! The pervasiveness of images in American society is something with which all people all ages must constantly contend. For the middle schooler this stereotypy is a viable attachment since these young girls and boys are changing in so many ways and must use others and images as their criteria for evaulating personal change. Research on physical attractiveness indicates that early adolescents are very concerned about their appearance (Adams, 1977; Lerner, Orlos, & Knapp, 1976). Boys identify strongly with the masculine (mesomorphic) look, which is characterized by their height, shoulder width, and body proportions. Girls express concern over the shape of hips, legs, breast, and waist. The prevalence of athletic events, beauty contests, and media productions that stress beauty, manliness, and "sexiness" help our emerging adolescents plug into stereotypes. There is no question but that preadolescents are both vulnerable and impressionable. The external environment often capitalizes on these traits, sometimes to the betterment and sometimes to the detriment of the youths themselves.

Learner Characteristics

One important developmental ability the learner has is to *organize knowledge and concepts into problem-solving strategies* (Thornburg, 1974b). The preteen falls within Piaget's concrete and formal operations stages (Inhelder & Piaget, 1958). The concrete stage is a very conceptual stage where the preadolescent organizes information around categories or concepts which are generalizable from one instance to another. The formal stage is not characterized only by abstract thought. It utilizes, in addition, the components of logic and reasoning in making decisions. This process is the beginning of the type of thought process that exists in most adults.

The developmental aspects of these two stages can be enhanced within the middle school environment. Learning experiences can be structured for youth so that there is an easier transition to the advanced stages of thought. By grades five and six, information is ordered, organized, and structured within the mind. By grades seven and eight, deductive reasoning and reflective thinking are operating, thus lending greater flexibility to the earlier thought processes.

Another important characteristic is that preteens show *interest in planning many of their own learning experiences* (Thornburg, 1979b), in being self-directive. They have inquiring minds that cause them to go beyond many ideas presented in class and into many personal interest areas. Teachers and

the curriculum should have enough flexibility to let students explore personal academic interests at various times. This statement should not be interpreted to mean that the teacher should abdicate responsibility for directing learning in lieu of the student's rights to be self-directed. I should hope, however, that it comes to mean greater flexibility, greater awareness of the value of student input, and greater willingness to structure teaching-learning activities within the context of the learner's natural environment.

Della-Dora and Blanchard (1979) in the current ASCD monograph entitled "Moving Toward Self-Directed Learning" suggest the following three ways in which the school structures what is to be learned:

1. *School-Directed.* The school and/or teacher select all required subject matter, define all educational goals, and also determine the nature of all elective courses or activities offered.
2. *Mid-Point.* Students have a voice in selection of subject matter to be learned for at least part of each day or each year. They do this either in required school courses or in selecting certain activities, and/or in proposing what electives should be available.
3. *Self-Directed.* Teachers and students cooperatively establish and use criteria for selecting subject matter. These criteria typically take into account goals, current student interests and needs, possible value for college preparation, potential value for career choice and preparation, necessary general citizenship knowledge and skills, and contributions to understanding self and others (p. 5).

Whether you and I agree with the specific way in which they delineate the options is not as important as understanding the concept of student involvement in the teaching-learning decision-making process. It is congruent with their intellectual capacities and their self-motivating desires to learn within their total environment.

The *emerging value system* of the preteen is the third learner characteristic I wish to discuss (Thornburg, 1970). Throughout the first eight years of life a child's primary value source is his or her parents (Thornburg, 1973). Values are represented through moral teaching, such as the concepts of right or wrong and good or bad. Even when the child begins school, parents remain more dominant than teachers in value teaching.

During preadolescence there is a shift from parents being the predominant influence on behavior to peers becoming this predominant influence. This sets in motion the likelihood that many parents, teachers, and other adults will be challenged in some of their moral and value teachings. Preteens will identify discrepancies between their parents and themselves. They will ask why a behavior, such as profanity, is acceptable for the parent but not the child. They are not as likely to accept the explanation "because parents are older," as may have been true in previous generations. They will wonder why teachers favor some students and pick on others. Then, their friends will be their greatest sympathizers in the process of trying to unscramble the discrepancies. Indeed, this *is* the way in which moral development change occurs.

The impact of individuality within the society throughout the 1970s has been rendered literally by many preteens to mean "no one has the right to tell them what to do." This belief has been reinforced by older adolescents, some parents and teachers, and by the media. The question is not whether or not an individual has rights but whether we can get a person to explore personal rights within a larger framework, namely, individual rights accompanied by individual responsibility. In a real sense adults and society have done children

and youth an injustice by failing to teach them the reciprocal elements of rights and responsibility. There are multitudinous opportunities for preadolescents to hear of and carry out the idea of individuality. The critical issue in the middle school is to teach the corollary elements so that the basis upon which preteens can make value judgements and act upon them is complete.

Teacher Characteristics

As our information base on pre- and early adolescence continues to increase, it is absolutely essential for the effective teacher to keep abreast of what is happening. What this requires is involvment with preteens. If teachers dislike their jobs, are negative with students, or are too routine in their classroom teaching, the effect on students will be negative, thus interfering with effective teacher-student interaction. With childhood stability breaking up, preadolescents need positive teachers who can guide them into new learning experiences.

The teacher must remember that *learning must be functional to the student* (Thornburg, 1979b). Student interest in academic learning is directly related to how useful the student thinks learning is. Here I must underscore the concept of *relevance*. If the teacher "stresses things students already know, could care less about, or that are so removed from the student's immediate life that they have no relevance, most students will disregard such teaching" (Thornburg, 1979b, p. 78).

Teachers must not actively compete with students' friends or with powerful external influences such as the media. No matter what a teacher does, he or she will never be as popular or well-liked by any single student as much as that student's friends. This is neither demeaning nor uncomplimentary to the teacher. Rather, it is the recognition that within the school environment the perceptual worlds of teachers and students are significantly different. A student needs both—other students and teachers. The professional role of the teacher can promote reciprocal respect which should not be violated by teachers over-identifying with students.

The average seventh grader spends six hours a day watching television (Srygley, 1978). Programs and advertisements are geared to the interests and energies of preteens in a way so powerful and influential that the critics are coming out of the woodwork. Its effects are unknown, yet speculation is that it not only promotes violence and insolence in preteens but actually affects the child's ability to think and be active.* Earlier we talked about how important problem-solving skills are. Some writers have asserted that extensive television viewing may retard the development of problem-solving skills and promote mediocrity of thought (Hartman, 1978; Hornik, 1978).

Whether these assertions are true or not, one thing seems certain. Preadolescents use television as a major entertainment form and exercise an allegiance to it that will not be abandoned until during adolescence. Teachers must play a different role, which is fulfilled through teaching and not entertaining. The teacher who resorts to World War II fighter pilot stories may perceive himself as entertaining, but he can't match Mork. At the same time, Mork cannot build in the student the skills a teacher can, one of which could be whether to watch Mork or not. The purposes of these two major

*For an elaborate treatment of this issue, see Salomon, G. *Interaction of media, cognition, and learning*. 1979.

non-home influences on a preteen's life are distinctly different. In the interest of maximizing learning, teachers should remember this.

Learning must include understanding social contact and responsibility (Thornburg, 1979b). It is important that teachers be aware of the importance to preadolescents of having friends. Perhaps some teachers perceive this as a potential problem within the classroom rather than the normal development of social skills. An aspect of effective instruction includes helping students learn how to make friends and get along with others. Teachers should not see such companionship as a threat to classroom order or management. It simply is not true that kids always cause trouble or do unacceptable things when they get together. Teachers should support groups of early adolescents as well as the individual person.

It is important to realize that *much student achievement is related to gaining status with friends* (Thornburg, 1979b). Permit me to cite a personal example here. When my daughter was in the sixth grade she had a strong relationship with another girl. They did many things in and out of school together, including sitting next to each other whenever they could. On one occasion my wife and I received a call from her teacher asking for a conference. In the conference she stated that my daughter and her friend were being very disruptive in the classroom and she had separated them. Since they had been separated my daughter's grades had gone down, as had her friend's. After some discussion, we suggested that the girls should be presented with reasons why they were moved and why disruptive behavior is a problem within the classroom and then seated next to each other again. Within the same day their high achievement began again. Their ability to learn was their way of winning and maintaining status with each other.

It is important to recognize that the opposite holds true for many students. In the process of making friends many underachieve so they do not make their friends feel inferior and lose them. This is especially true if it is correlated with physical development, that is, those who are inferior physically do not risk being unpopular by being good achievers.

Students should not be expected to conform to everything at school (Thornburg, 1979b). The teacher's standard often appears to be the only acceptable standard of behavior within the classroom; the principal's in the hallways. This is too restrictive in the sense that students are expected to conform to ways that may or may not meet many individual needs. As students come into our school environments more diverse than ever before, we must respond by being more diverse than ever before. It is an unfortunate situation when the student's security and success in the classroom is dependent upon conforming to the school or teacher standard. Teachers should see their role as helping individuals learn how to better live with themselves, rather than expecting them to accept another person's way of doing things as always the best way.

Summary. The ideas I have discussed are vital if we are to meet the needs of our preteens within the school environment. The needs are not always evident, nor the strategies to resolve such needs. However, the emerging adolescent is so potentially dynamic that our energies, without question, are warranted.

References

Adams, G. R. Physical attractiveness research: Toward a developmental social psychology of beauty. *Human Development*, 1977, *20*, 217-239.

Della-Dora, D. and Blanchard, L. J. (Eds.). *Moving toward self-directed learning*. Alexandria, VA: Association for Supervision and Curriculum Development, 1979.

Dunphy, D. C. The social structure of urban adolescent peer groups. *Sociometry*, 1963, *26*, 230-246.

Hammer, S. L. and Owens, J. W. M. Adolescence. In D. W. Smith & E. L. Bierman (Eds.), *The biologic ages of man*. Philadelphia: W. B. Saunders, 1973, 139-153.

Hartman, H. D. TV in American culture. *The crisis*, 1978, *85*, 15-18.

Hornik, R. C. Television access and the slowing of cognitive growth. *American Educational Research Journal*, 1978, *15* (1), 1-15.

Inhelder, B., and Piaget, J. *The growth of logical thinking from childhood to adolescence*. New York: Basic Books, 1958.

Lerner, R. M., Orlos, J. B., and Knapp, J. R. Physical attractiveness, physical effectiveness, and self-concept in late adolescence. *Adolescence*, 1976, *11*, 313-326.

MacMahon, B. *Age at menarche*. National Center for Health Statistics, Vital and Health Statistics. Series 11: Data from the National Health Survey, No. 133, 1970.

Salomon, G. *Interaction of media, cognition, and learning*. San Francisco: Jossey-Bass, 1979.

Sommers, B. B. *Puberty and adolescence*. New York: Oxford University Press, 1978.

Srygley, S. K. Influence of mass media on today's young people. *Educational Leadership*, 1978, *35*, 526-529.

Tanner, J. M. Growing up. *Scientific American*, 1973, *229*, 35-42.

Tanner, J. M. *Growth in adolescence* (2nd ed.): Oxford: Blackwell Scientific Publicatioins, 1962.

Thornburg, H. D. Adolescent attitudes toward working women. Paper read at the annual convention, Rocky Mountain Psychological Association Meeting, April, 1979 (a).

Thornburg, H. D. *The bubblegum years: Sticking with kids from 9 to 13*. Tucson: H.E.L.P. Books, 1979 (b).

Thornburg, H. D. Adolescent attitudes toward women's roles. Paper read at the Southwestern Psychological Association Meeting, April, 1974 (a).

Thornburg, H. D. *Preadolescent development: Readings*. Tucson, The University of Arizona Press, 1974 (b).

Thornburg, H. D. Learning and maturation in middle school age youth. *Clearing House*, 1970, *45*, 150-155.

An Interactive Model: Three Theoretical Constructs Related to Preadolescent Development and their Educational Implications

Michael A. James

Introduction

A common question among some professional educators and lay persons concerning middle level education is, "What research do you have to support the contention that if traditional education for this age group is not working then why should we change and endorse a new system or organization of educational practice?" This is a good question that many of us have been trying to answer for some time. But as Alexander points out, the movement toward other middle level education practices is still in its infancy and answers take time. (Alexander, 1978, p. 19)

Yet another question might be, "On what theoretical basis should research be conducted in order to support the middle school movement and make changes in both teacher education preparation and classroom practices related to middle level education?"

I use the term "middle level education" in order to designate those structures and strategies I associate with "good" learning and teaching practices for kids who are between the ages of 10 through 14. I try to avoid the trap of labelling these kids with further jargon or restricting their educational environment to any one organizational pattern.

It is the latter question I wish to address today since without an understanding of theory, practice makes no sense. To this end, I have designed a three-dimensional model that incorporates or synthesizes three bases for discussing the social and intellectual development of preadolescents and the educational implications of this synthesis.

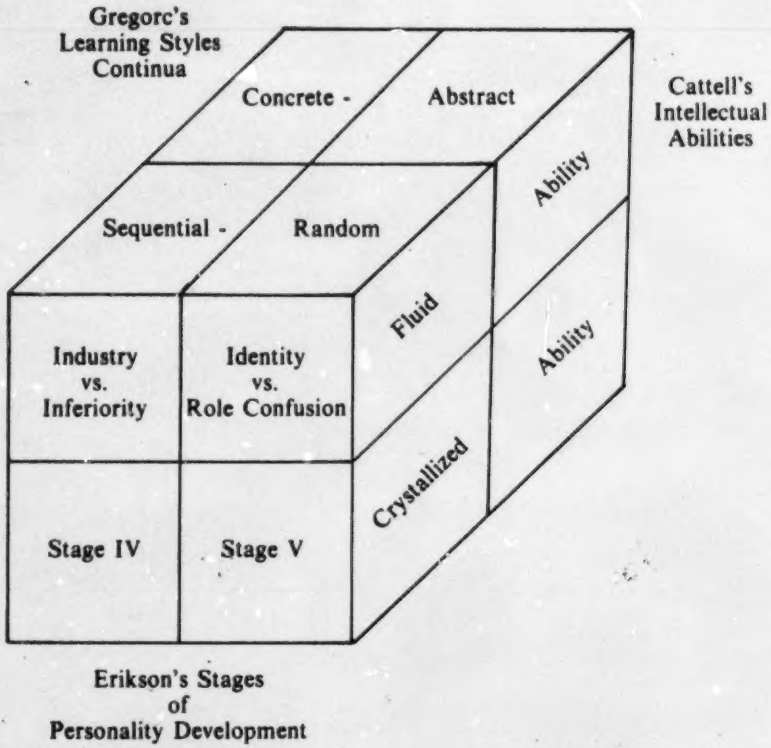
In order to tackle such a task, I can only touch briefly on the main points of each theoretical position, since literally volumes have been written about each. Some of the ideas are based on my own research into Raymond Cattell's definition of intellectual abilities and this age group, and how instructional treatment can be designed to capitalize on the strengths of these students. Interfaced with these ideas, I have chosen to include work done by Erik Erikson on ego (identity) development and by Anthony Gregorc on learning styles continua. Although these names may not be as "everyday" as Piaget, Havighurst, and Dunn, I believe the ideas of these three people—Cattell, Erikson, and Gregorc—presented as theory, backed extensively by research, provide a viable approach to discussing educational practices appropriate for kids in the middle.

The Model

The model is an oversimplified visualization of my thinking. Each of the three planes is divided into two equally represented segments when in fact, as

Michael James is Professor of Education, Wichita State University, Wichita, Kansas.

will be seen after further explanation, the whole either may not be equally divisible or may not represent all of the available options.



Theoretical Constructs

Raymond Cattell's Theory of Intellectual Abilities

The studies of Cattell and others (Cattell, 1963, 1971; Cattell and Butcher, 1968; Horn, 1965; Horn and Cattell, 1966) have given evidence supporting the general intelligence ability distinction labelled by Cattell as fluid and crystallized intelligence. Fluid intelligence appears to be a factor of general brightness or ability, rather independent of schooling or experience. Crystallized intelligence can be described as acquired knowledge and skills. Cattell's investment theory describes the development of fluid ability and its relationship to crystallized ability.

From the different abilities composing fluid and crystallized intelligence, Horn (1967, 1968) specified the pattern of abilities subsumed under the generic headings. He said that fluid intelligence included: (a) induction, (b) span of apprehension, (c) general reasoning, (d) associative memory, and to a lesser degree, (e) deductive reasoning.

The pattern of abilities incorporated into crystallized intelligence, according to Horn, consisted of: (a) verbal comprehension, (b) experiential evaluation, (c) formal reasoning, (d) number facility, and to a lesser degree, (e) general reasoning.

James, (1973) conducted research using these variables to construct two different instructional treatments and assess their effect on each of three groups of 12-year-old students as related to the acquisition of a mathematical concept. Three groups (N = 60 each) of sixth-grade students were measured on fluid and crystallized ability, given instruction capitalizing on one of the two abilities or no instruction (control), and pre- and post-tested for achievement of the 2n subset mathematical rule. The independent variables were: (1) crystallized intelligence, (2) fluid intelligence, and (3) sex. The control variable was the mathematical concept pre-test, and the dependent variable was the mathematical concept post-test.

The results of the original study revealed that there were significant achievement differences and an interaction between treatments and levels of fluid intelligence. Students who were assessed as being in the middle or lower two-thirds of the range of fluid intelligence scores achieved better where the teaching-learning procedures were individualized to coincide with their intellectual aptitudes. Students who were assessed as being in the high one-third of their intellectual ability achieved well regardless of the instructional treatment they received. There were no achievement differences between sexes.

Erik Erikson's Theory of Personality Development

Erikson's epigenetic theory of ego (identity) development (Erikson, 1968) contains two stages (IV and V) related to middle school age students. The "crises" to be resolved are industry versus inferiority and identity versus identity confusion.

Pubescence, according to Erikson, is characterized by rapidity of body growth, genital maturity, and sexual awareness. Because the latter two aspects are qualitatively quite different from those experienced in earlier years, an element of discontinuity with previous development occurs during this period. Youth is confronted with a "physiological revolution" within him that threatens his body image and his identity. He becomes preoccupied with what he "appears to be in the eyes of others" as compared to what he feels he is (Erikson, 1950, p. 228).

Adolescence is the period during which a dominant positive ego identity is to be established. Erikson maintains that the study of identity has become extremely important. Particularly for the pre- and adolescent, identity—the establishment and reestablishment of sameness with one's previous experiences and a conscious attempt to make the future a part of one's personal life plan—becomes subordinated to sexuality. If ego identity is not satisfactorily established in these stages, there is a danger that role diffusion will endanger further ego development.

Erikson's treatment of the approach to and adolescent development details behavioral changes in the context of a series of developmental stages. The Eriksonian theory is a complete theory of ontogenetic development; that is, it outlines in stages the entire life span of the individual from birth to death in terms of critical challenges to personality development. It also stresses the relationship of each stage and its challenge to each of the stages; thus any one stage is related to all the stages that precede and follow it. Each of the eight

stages is identified as a task or challenge whose resolution is achieved by effecting a balance between two polar opposite personality states.

Anthony Gregorc's Learning Styles Continua

Gregorc defines learning in its broadest sense as the process of adaptation to what is external *and* to what is internal. Style, then, is the distinctive cluster of behaviors or manner of acting that a person demonstrates. "People 'tell' us how they learn through their behavior." (Gregorc, 1978) Each person has preferences about information acquisition. Gregorc refers to the two continua of concrete to abstract and sequential to random as paired factors in how people learn best. Sets of these factors joined to form four distinct learning preference patterns or modes (Gregorc, 1977, p. 21). They are:

Concrete sequential
Concrete random
Abstract sequential
Abstract random

The characteristics of each paired preference are best understood by reference to the chart on page 12 (Gregorc, 1978).

The Synthesis

Perhaps as Gregorc (1977) suggests there is a need to look at the phenomenological definition of the word "individual". The parts that make up that word can form a focus for pulling together all that has been said so far, plus they can provide the candlepower to see our way down the long, dark tunnel we often find ourselves in when we try to explain middle level education. Individual equals *indivi* (inseparable) and *dual* (duality).

As educators we too often assume the role of biologist and apply the process of microscopic dissection when we look at the preadolescent. We see the whole, but we look at the parts and then we try to understand the whole in terms of the various parts. I tend to believe that with something as complex as the preadolescent the whole is the sum of its parts. Yes, every preadolescent has intellectual abilities, but they certainly vary in type, if we believe Cattell and Horn, and complexity. Yes, every preadolescent has a personality, but it is the unique accumulation of past resolutions of developmental crises, if we believe Erikson. Yes, each preadolescent has a learning preference that lies somewhere between concreteness and abstraction on the one hand and sequence and randomness on the other hand, if we believe Gregorc.

But if we understand these dualities in perspective then we must realize that they are as inseparable as the multidimensionalities that are the preadolescent. These are but a few of the dualities that exist as we study the learning about and teaching of these kids. The point is that ten years ago I was a whole being with many parts. Over the past ten years I have grown and tried diligently to learn more about myself and reach more of my potential. Today I am not the whole of a decade ago, but I am a new whole with better understood parts and many more facets. Ten years from now, if I continue to become more self-actualized, I will be an even bigger, and hopefully better, whole for my needs will allow me to continue to grow.

So it is with the preadolescent. Ten years ago, very little was really known or understood about the parts that make up these kids. But in that ten-year time, we've looked harder and answered some tougher questions, which leads to today's beginning understanding of some of the inseparable dualities that are the preadolescent.

CS	AR	AS	CR
SOURCE PREFERENCES:	SOURCE PREFERENCES:	SOURCE PREFERENCES:	SOURCE PREFERENCES:
Concrete-from concrete reality, special objects or actual instances	*Abstract*-apart from concrete reality, special objects or actual instances	*Abstract*-apart from concrete reality, special objects or actual instances	*Concrete*-from concrete reality, special objects or actual instances
Sequential-in linear manner; successive connected parts; structure	*Random*-multiple sources contributing without an apparent aim; flexible structure	*Sequential*-in linear manner; successive connected parts; structure	*Random*-multiple sources contributing without an apparent aim; flexible structure
BEHAVIOR:	BEHAVIOR:	BEHAVIOR:	BEHAVIOR:
Specific use of one or more of the five senses; direct experience	Uses sixth sense for "vibrations"; attuned to body language, color and mood	Uses conceptual pictures to decode symbols (written, verbal, and/or image)	Uses insight; makes intuitive leaps and gets "gist" of ideas or situations
Sees situations in blacks and whites	Sees situations in grays	Sees "the" answer to situations	Sees "an" answer or multiple answers to situations
Is cognitively-based	Is affectively-based	Is analytically cognitively based	Is cognitively-affectively based
Accepts official authority	Accepting of person authority; medium in the message	Accepts referent authority (documentation important)	Accepts varying forms of authority if considered legitimate
Has direct practical pay-off orientation	Has multi-sensory personal experience and group orientation	Has vicarious, hypothetical, theoretical, analytical, evaluative orientation	Has problem-solving, application orientation
Anticipates "good" performances; gives and expects to receive primarily corrective feedback	Anticipates subjective-personal performance; gives and expects to receive approval feedback	Anticipates "excellent" performance; gives and expects to receive primarily corrective feedback	Anticipates mixed performances; gives and expects to receive approval and corrective feedback
Sees discrete parts	Sees a whole	Does models with logical parts	Sees a whole with overlapping parts
Follows step-by-step directions; careful attention to detail	Follows broad overarching guidelines under minimal structure, restraint and limitation	Follows overarching substantative, logical guidelines and general procedures	Follows overarching guidelines with reasonable structure, restraint and limitation
Has low tolerance for distraction	Likes a "busy" environment	Has low tolerance for distraction	Likes a stimulus-rich environment

The preadolescent needs to experience the same dimensions of exploration into the self—an exploration that can be facilitated by our understanding and encouragement. The whole kid that we think we know today is but a part of the whole kid we will know tomorrow, if only the kids' perception of this evolution coincides with ours.

Educational Implications and Practices

Just as there are so many parts of the whole child to explore, understand, and appreciate, there *are* answers to the question, "What do we do now?" William Purkey suggests we "invite school sucess." He defines an invitation as "a summary description of messages—verbal and non-verbal, formal and informal—continuously transmitted to students with the intention of informing them that they (the learners) are responsible, able, and valuable" (Purkey, 1978, p. 3).

Dr. Calvin Taylor, director of the Institute for Behavioral Research in Creativity at the University of Utah, advocates a multiple talents approach to teaching, with the nurturing of thinking processes in talents such as productive or creative thinking, communications, forecasting, decision making, and planning in addition to academic talent. Taylor maintains that development in several talent areas relevant to the here-and-now world we live in would increase the chances that every student in the classroom could become successful in at least one of the talent areas, and, as his self-concept is enhanced by these successes, each student would begin to function more fully in other areas (Talents Unlimited, 1974).

Richard Suchman has developed an inquiry training process that allows the student to become more of an autonomous learner through the information processing strategies of inquiry. Although usually applied to the physical, biological, and geological sciences, the learner can master the process of inquiry and apply the questioning techniques to all other areas of interest (Weil, 1978).

William Gordon developed Synectics for improving creative problem-solving abilities. When applied to middle level education, it can be used in many content areas and as a means of linking ideas across content areas. (Weil, 1978)

Timmerman has written a guide for teachers that shows the whys and hows of humanistic education for the preadolescent. His curriculum section called a "psychological curriculum" is based entirely on Erikson's theory of personality development (Timmerman, 1975).

These are but a few suggested resources that I've found helpful as I operate as a teacher educator. Each has a sound theoretical base and thereby can be counted on to deliver effective practices. The only thing left is for the teacher and all who work with preadolescents to explore their own being and need to facilitate the learning and growth of these vital natural resources.

References

Alexander, William M. How fares the middle school movement *Middle School Journal*. August, 1978, Vol. IX, No. 3.

Cattell, R. B. Theory of fluid and crystallized intelligence: A critical experiment. *Journal of Educational Psychology*, 1963, *54*, 1-22.

Cattell, R. B. *Abilities: Their structure, growth, and action*. Boston: Houghton Mifflin, 1971.

Cattell, R. B. and Butcher, H. J. *The prediction of achievement and creativity*. Indianapolis: Bobbs-Merrill, 1968.

Erikson, E. H. *Childhood and Society*, Ed. 2, New York: W. W. Norton, 1963.

Erikson, E. H. *Identity: Youth and Crisis*, New York: W. W. Norton, 1968.
Gregorc, A. F. NCSI/ASCD Institute on Learning and Teaching Styles, Kansas City, 1978.
Gregorc, A. F. A new definition of individual *NASSP Bulletin*, February, 1977, 20-26.
Horn, J. L. Fluid and crystallized intelligence: A factor analysis and developmental study of structure among primary mental abilities. Unpublished doctoral dissertation, University of Illinois, 1965.
Horn, J. L. and Cattell, R. B. Refinement and test of the theory of fluid and crystallized general intelligence. *Journal of Educational Psychology*, 1966, *57*, 253-270.
Horn, J. L. Intelligence—Why it grows, why it declines. *Trans-Action*, 1967, *5* (1), 23-31.
Horn, J. L. Organization of abilities and the development of intelligence. *Psychological Review* 1968, *75*, 242-259.
James, M. A. The interaction between intellectual abilities and treatments on mathematical concept achievement in the sixth grade. Unpublished doctoral dissertation, University of Arizona, 1973.
James, M. A. and Knief, L. M. Interaction of general, fluid, and crystallized ability and instruction in sixth grade mathematics. *Journal of Educational Psychology*, 1978, *70*, No. 3, 319-323.
Mobile County Public Schools, *Talents Unlimited*, 1974.
Purkey, W. W. *Inviting School Success: A Self-Concept Approach to Teaching and Learning*, Belmont, California: Wadsworth Publishing Co., 1978.
Timmerman, T. *Growing up alive*, Amherst, Maine: Mandala Press, 1975.
Weil, M. and Joyce B. *Information Processing Models of Teaching*, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.
Weil, M. and Joyce B. *Personal Models of Teaching*, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.

Variations in Pubertal Development and the School System: A Problem and A Challenge

Allan Drash, M.D.

The professional who spends a significant amount of time working with adolescents is aware of many characteristics that are relatively unique or are of special importance to this age group. Success in relating to the adolescent, whether it be in the area of education, athletic activity, counseling, or health supervision is dependent, at least in part, on an understanding of the physical and emotional changes that characterize the transition from childhood to full physical maturity.

The purposes of this communication are (1) to review the factors involved in the control of physical growth and sexual maturation, including the variability in normal rates of progression, (2) to provide information regarding techniques available for the grading of levels of sexual maturation, (3) to identify those extremes of the maturational process which should lead to medical supervision, and (4) to discuss possible application of this information in the educational setting.

Puberty, or adolescence, is that phase of biological development during which time the gonads increase in size and begin to synthesize and release specific steroid hormones that stimulate the growth of the genital organs as well as accelerate total body growth. Gonadal maturation occurs with the production of sperm and ova. Puberty is considered to be terminated when the organism has reached complete sexual maturity and linear growth has ceased. Puberty does not begin in a biological vacuum but rather is the culmination of endocrine and metabolic events that have their origin in fetal life.

Physical Growth and its Regulation

Growth and maturation, the primary activities of childhood, are interlocking functions that lead to increase in body (or specific organ) size and increase in functional capability. Growth of the organism may result from increase in cellular number (hyperplasia) or increase in cell size (hypertrophy), or a combination of the two. Intrauterine growth is primarily due to rapid cell multiplication while extrauterine growth, particularly after the first year or so, results from cellular hypertrophy.

Growth of the child is a complex process. The availability of adequate food supplies, an intact gastrointestinal system to insure absorption, highly refined systems for the storage and retrieval of energy, and an endocrine system that can respond immediately to changing demands are all essential if growth is to continue at a normal rate.

Malnutrition is the single most important factor in interference with the achievement of full physical potential. Although it has been well established for many years that malnutrition in infancy and childhood will lead to

Reprinted with permission from *Transescence: The Journal on Emerging Adolescent Education*, a publication of Educational Leadership Institute, Box 863, Springfield, MA 01101, Dr. Conrad Toepfer, Editor.

Allan Drash is Director of the Clinical Study Center, Children's Hospital, Pittsburgh, Pennsylvania.

delayed physical growth and sexual maturation, recent studies emphasize the importance of this problem in the United States. Further, several investigators have demonstrated that malnutrition during pregnancy may impair multiplication of brain cells in the fetus and produce permanent mental retardation.

The endocrine system is especially important in controlling the rate of growth and eventual sexual development. The control of endocrine function resides in that section of the brain known as the hypothalamus. Based upon the receipt of neutral and biochemical messages (a feedback mechanism) the hypothalamus directs the release or suppression of release of hormones from the anterior pituitary gland, formerly referred to as the "master gland," but now known to be a "slave" to higher authority. The anterior pituitary synthesizes and releases growth hormone (GH), thyroid stimulating hormone (TSH), adrenocorticotrophic hormones (ACTH) and the gonadotropins, luteinizing hormone (LH), and follicle stimulating hormone (FSH). Growth hormone in concert with insulin, elaborated from the beta cells of the pancreas, are the major factors responsible for controlling the rate of growth in the preadolescent period. Thyroid hormone, produced by the thyroid gland under control of TSH, is also of great importance. Deficiency of any of these three factors will be associated with impairment of physical growth as well as clinical disease.

Growth and Maturation During Puberty

Sexual maturation occurs following a change in the hypothalamic-hypopituitary-gonadal relationship. This is diagrammatically presented in Fig. 1.(1) In the preadolescent child, the gonads synthesize hormones at very low concentration, estrogen from the ovaries and androgen from the testes. Those centers in the hypothalamus responsible for control of LH and FSH release are very sensitive to low levels of sex hormones. Consequently, a constant inhibitory message is delivered to the pituitary, blocking the release

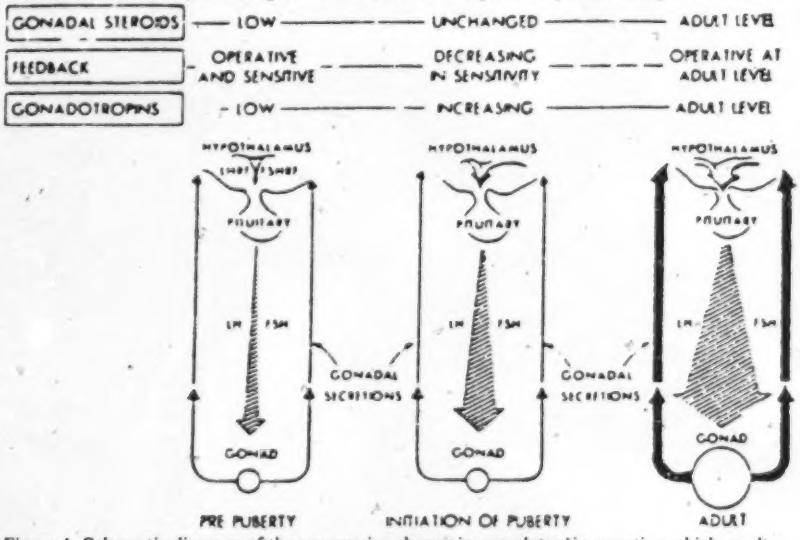


Figure 1. Schematic diagram of the progressive change in gonadotropin secretion which results from a decrease in hypothalamic sensitivity to gonadal steroids. (From Reiter and Root, Ref. 1)

of LH and FSH, thus preventing sexual maturation. The first step in pubertal development appears to be the decrease in hypothalamic sensitivity to gonadal hormone levels, thus lifting the inhibition, allowing release of LH and FSH. The factors responsible for decline in hypothalamic sensitivity are not well understood but relate to the stage of biological maturation of the organism, which is in some way correlated with a critical weight of the organism. This interesting concept will be discussed more fully later.

With a readjustment of the hypothalamic gonadostat to a decreased level of sensitivity to the circulating levels of sex steroids (estrogens and androgens), the message from the hypothalamus to the anterior pituitary becomes stimulatory, leading to release of LH and FSH and the eventual re-establishment of a new steady state with the achievement of full sexual maturity.

The gonadotrophic hormones produced by the anterior pituitary are structurally the same in males and females and act in concert to produce mature gametes and the genital system necessary to deliver and sustain the gametes. The somewhat confusing nomenclature relates to the action of these hormones on the ovary: follicle stimulating (FSH) referring to the development of a mature follicle, its rupture and release of an ova, and luteinizing (LH) referring to the changes that occur structurally in the ovary following release of the ova as well as the hormonal changes that are associated. The total process in the female is a cyclic one. There is a highly integrated feed-back system, the variables being changing concentrations of estrogen, progesterone, LH and FSH. When working properly, the system delivers a viable ovum approximately once monthly into a milieu that is favorable for its receipt and nurture so fertilization can take place.

The process in the developing male is, at least on the surface, considerably less complex. FSH and LH stimulation lead to maturation of the germinal epithelin of the testes and sperm formation. In addition, interstitial cell hyperplasia results with increasing testosterone synthesis There is little or no cyclic nature to the hypothalamic-pituitary-testicular axis. Sperm and testosterone production are relatively constant once sexual maturity is reached.

The Evaluation and Classification of Adolescence

Scientific approach to the study of the physical aspects of adolescence requires use of accurate, reproducible, objective techniques for classifying the level of sexual maturation achieved by an individual. The classification system developed by Tanner has been widely accepted. It involves inspection and classification into one of five possible categories based upon comparisons with standardized photography of the genitalia, breasts, and distribution of sexual hair. The Tanner stages are: (1) prepuberty, (2) early puberty, (3) mid-puberty, (4) late puberty, and (5) sexual maturity.

The concept of biological age, in comparison with chronological age, has important application in the study of maturation as well as in the evaluation of an individual with problems of growth or sexual development. The "skeletal or bone age," as determined by x-rays of the hand and wrist, provides the most sensitive method of determining how far along the growth and maturational process of a child has moved. The method involves comparison of the x-ray films from a particular child with an atlas of films, arranged in chronological order from birth through full sexual maturity, derived from study of thousands of normal children.

The scientific study of the endocrinology of physical growth and sexual maturation has expanded rapidly in the past ten years with the availability of new, highly sensitive techniques for the measurement of hormonal levels in blood and urine. It is now possible to measure accurately all the hormones involved in control of the growth process. Investigators have developed standards for the normal range of concentrations of LH, I SH, growth hormone, and the sex steroids in the preadolescent child at each of the Tanner stages of development and for the sexually mature individual.

The Variability in Rate of Pubertal Development

Nothing characterizes adolescence more than variability. This is certainly true in terms of rate of physical growth and the progression of sexual maturation. A number of factors are known to influence the rate of development. The level of nutrition is the single most important factor if we think in world-wide terms. Chronic malnutrition delays growth prior to and during adolescence and impedes the rate of sexual maturation. Even modest reduction from optimal nutrition will slow the developmental process. In Fig. 2, from Tanner, is illustrated the secular trend of age at menarche. It can be seen that in the past 120 years there has been a linear decline in the age of the first menstrual period. In 1840 the average age of menarche was 17 years, while in 1960 it was less than 13 years of age. This trend shows no signs of plateauing. It is felt by many investigators to be an expression of improved nutrition.

The work of Frisch is particularly important in this regard. He has accumulated evidence that strongly supports the concept of a critical body mass or weight necessary to initiate sexual development. Tables I and II, taken from his work, provide detailed information for both boys and girls in

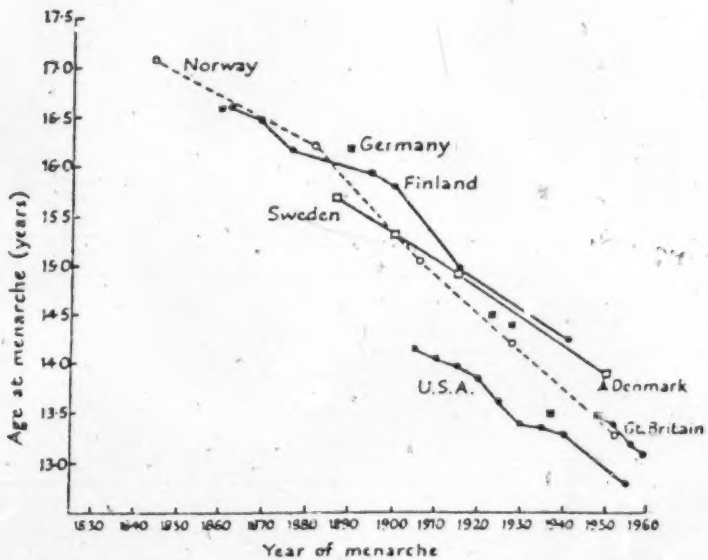


Figure 2. The secular trend in the age at menarche as revealed by data from different countries. (From Tanner, 1962, Ref. 2)

TABLE I. Mean (± SE) age, height, and weight of girls at initiation of the adolescent spurt, peak velocity, menarche, and age 18. (From Frisch, Ref. 4)

Adolescent event	No.	Age of height event (yr)	Age of weight event (yr)	Height [a] (cm)	Weight [b] (kg)
Initiation of spurt (Frisch & Revelle, 1971a)	184	9.6±0.1	9.5±0.1	136.5±0.84	30.6±0.30
Peak velocity (Frisch & Revelle, (1969b)	170	11.8±0.1	12.1±0.1	146.5±0.50	39.3±0.45
Menarche (Frisch & Revelle, 1970, 1971b)	181	12.9±0.1		158.5±0.50	47.8±0.51
Age 18 (Frisch & Revelle, 1970, 1971b)	181	_____		165.6±0.48 [b]	57.1±0.57 [c]

[a] Increases significantly ($p < 0.01$) with increasing age of event.
[b] Does not change significantly with increasing age of event.
[c] Decreases significantly ($p < .02$) with increasing age of event.

TABLE II. Mean (± SE) age, height, and weight of boys at initiation of the adolescent spurt, peak velocity, and age 18. (From Frisch, Ref. 4)

Adolescent event	No.	Age of height event (yr)	Age of weight event (yr)	Height (cm)	Weight (kg)
Initiation of spurt (Frisch & Revelle, 1971a)	179	11.7±0.1	11.6±0.1	147.3±0.49 [a]	36.9±0.36 [b]
Peak velocity (Frisch & Revelle, 1969b)	189	14.0±0.1	14.1±0.1	158.3±0.48 [b]	47.3±0.52 [b]
Age 18 (Frisch & Revelle, 1971a)	179			178.1±0.46 [c]	68.2±0.69 [d]

[a] Increases significantly ($p < 0.01$) with increasing age of event.
[b] Latest maturers slightly but significantly ($p < 0.01$) heavier than earlier age groups.
[c] Does not change with increasing age of event.
[d] Decreases significantly with increasing age of event.

terms of the relationship between height and weight and the events of puberty. It will be noted that sexual maturation begins in the female at an average weight of approximately 30 kg (66 lbs), that the period of peak height growth velocity (the adolescent growth spurt) occurs at a mean weight of 39 kg and menarche occurs at a mean weight of 48 kg. The mean increase in body fat in the female from initiation of sexual development through the menarche is 11 kg, equivalent to the storage of 99,000 calories. It is of interest that the calories needed to sustain a pregnancy are estimated to be 80,000. Nature provides both the systems necessary to establish fertilization and to sustain it.

Examination of the information on males shows that the entire maturational process is delayed an average of two years when compared with the female and occurs at an average weight of 7 kg heavier than in the female.

The information relating to weight and maturation has direct relevance in

the clinical setting. Obese teenagers almost invariably are taller and more advanced sexually than their peers. Conversely, the very thin and/or short child frequently develops later than his peers.

Genetic factors obviously account for much of the variability in growth and rate of sexual maturation in cultures where the level of nutrition is adequate. Early and late developers tend to occur in families. Other important factors include race, socioeconomic status, climatic conditions, physical and emotional stress. Earlier sexual development characterizes higher socio-economic groups, cultures in warm and temperate climates, and those groups subjected to less stress. An exception, illustrating the importance of race, is the earlier development regularly seen in black adolescents.

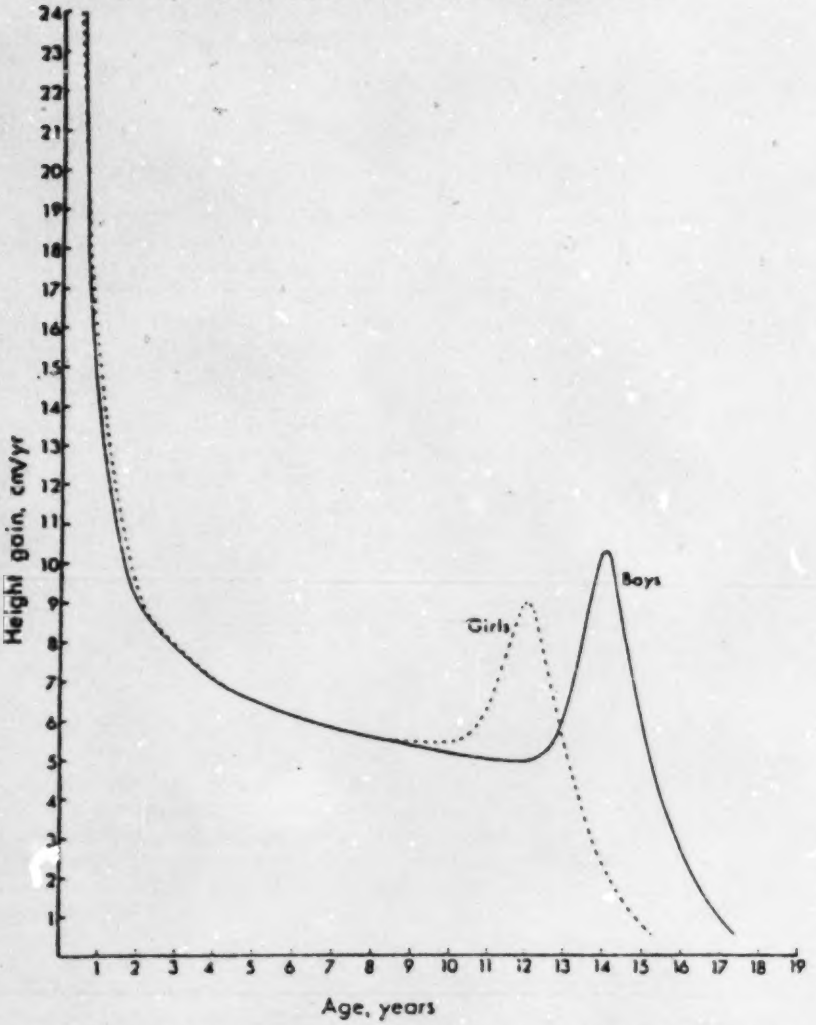


Figure 3. "Typical-individual" velocity curves for supine length or height in boys and girls. (From Tanner et. al. 1966. Ref. 5)

The adolescent growth spurt is a phenomenon of accelerated linear growth occurring during adolescence in almost all children. It is illustrated in Fig. 3, taken from Tanner. The figure is an acceleration, or velocity, growth chart rather than the more usual cumulative growth record. It demonstrates that linear growth is much more rapid in the infant (about 15 cm/yr for the 1-year-old), is relatively constant between 4 and 9 years of age (averaging about 6 cm/yr), that acceleration occurs about two years earlier and growth terminates two years sooner in the female. In the United States the average 13-year-old boy and girl are of the same size. However, the girl is in the declining phase of growth while the average boy is just entering the growth spurt. The greater velocity achieved and the longer growth phase in the male accounts for the greater eventual adult height.

The sequence of events in the developing female is usually breast budding, appearance of pubic hair, breast enlargement and nipple hypertrophy, appearance of axillary hair, menarche and completion of sexual maturation. The average interval from the initial changes to menarche is two years with an additional 18 months to two years needed to complete the maturational process. Individual variability in both sequence and timing is great. Fig. 4, from van'T Land et al, illustrates this. In this study approximately 15 percent of normal girls had established menstrual periods by 12 years of age, while 15 percent still had not experienced menarche by 15 years of age. Fig. 5, from Marshall, provides quantitative information on the stages and rate of maturation in both males and females. It will be noted that each stage is achieved earlier in the female and that the variability in timing is great. The mean±one standard deviation (encompassing approximately 65 percent of the normal group) includes a time spread exceeding two years at each developmental stage.

A comparison between affluent white and ghetto black adolescents, taken from our studies, is presented in Table III (8). Males, both black and white, average approximately 0.5 Tanner units behind age and race matched females. Comparison between black and white, age and sex matched, show that the black adolescents are more sexually advanced by a mean of approximately 0.3 Tanner units. Of 11-and 12-year-old black and white

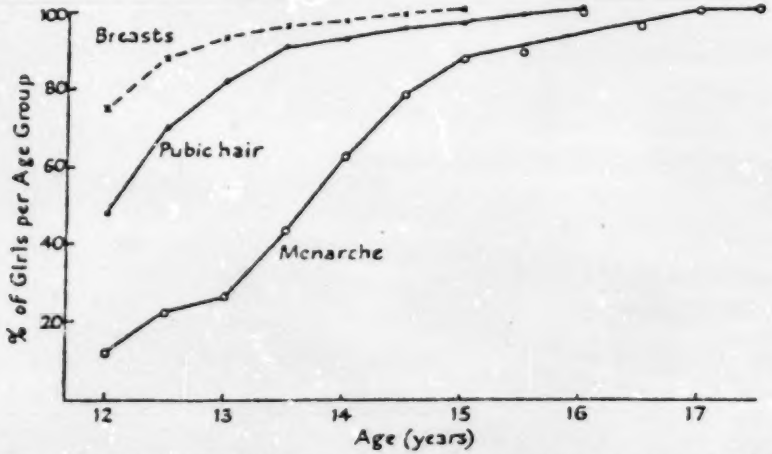


Figure 4. To show the variations in age at the onset of the characteristic signs of puberty in 1,484 girls. (Data from van't Land & de Haas, 1975, Ref. 6)

males, approximately 5 percent are sexually advanced (Tanner stages 4 and 5). Of girls in the same age category 10 percent of the white and 30 percent of the black are at a similar advanced stage of development.

Physiologic and Pathologic Alterations in the Maturational Process

The child or adolescent who is out of phase with his or her peers in any stage of maturation is an appropriate cause of concern to self and family. The educational and health care system should be alert to these concerns and know when to initiate more detailed evaluations.

Growth Problems

It is routine in most school systems for all children to be measured and weighed annually. This highly valuable information is rarely utilized to its maximum advantage. The information should be plotted on a standard percentile growth chart such as the Boston or Iowa growth grids. Significant fluctuations in the percentile position for either height or weight should alert the school nurse. Decline in growth rate, such as a fall from the 50th percentile to the 10th percentile over 2-3 years of observation, is almost invariably pathologic and should lead to a medical evaluation.

Children who are below the third percentile for height should be subject to close observation. If the record shows that the child has maintained a position on or about the third percentile for several years, his or her incremental growth is within normal limits and it is unlikely that a pathological process is

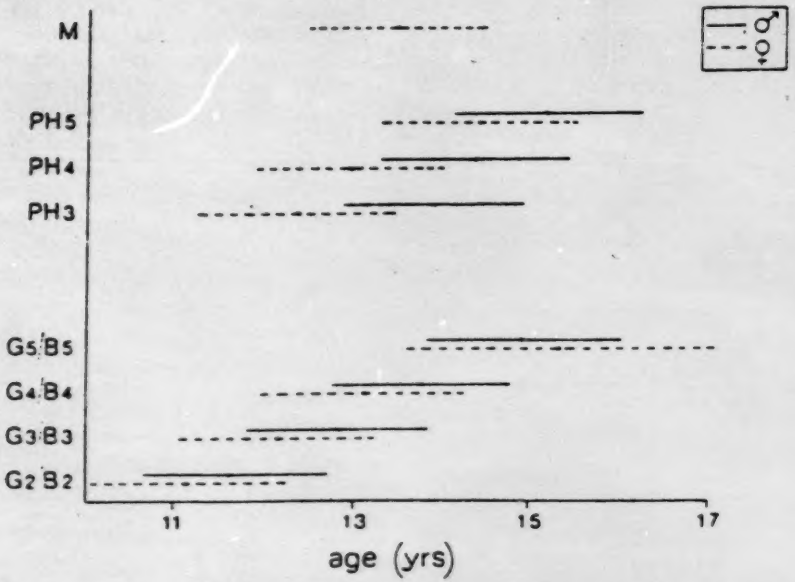


Figure 5. Mean age (± 1 s.d.) on reaching menarche (M); the various stages of pubic hair (PH); breast development in girls (B); and general development in boys (G). Boys shown by solid lines, girls by interrupted lines. (Data from Marshall and Tanner (1969, 1970, Ref. 7)

TABLE III. Comparison of age and sexual maturation. (Data from Nankin, et. al., 1974, Ref. 8)

	White							Black						
		Maturation					Maturation		Maturation					Maturation
Age-Years	Number	1	2	3	4	5	Mean	Number	1	2	3	4	5	Mean
Males:														
10±.5	0	–	–	–	–	–	–	17	9	5	3	–	–	1.5
11	48	15	32	1	–	–	1.7	17	4	10	3	–	–	1.9
12	82	14	44	18	6	–	2.2	28	4	12	9	3	–	2.4
13	76	3	30	29	10	4	2.8	34	1	9	11	12	1	3.1
14	25	.5	2	7	7	4	3.1	40	–	7	15	14	4	3.4
15	1	–	–	–	1	–	–	10	–	–	2	7	1	3.9
15.6-18.0	0	–	–	–	–	–	–	14	–	1	–	3	10	4.6
Sum	232	37	108	55	24	8		160	18	44	43	39	16	
Females:														
10±.5	0	–	–	–	–	–	–	8	–	5	3	–	–	2.4
11	72	16	41	13	1	1	2.0	10	1	6	1	1	1	2.5
12	73	5	31	24	9	4	2.7	15	–	6	3	6	–	3.0
13	91	–	14	32	39	6	3.4	15	–	3	6	4	2	3.3
14	19	–	2	4	6	7	3.9	9	–	–	2	3	4	4.2
15	0	–	–	–	–	–	–	10	–	–	2	5	3	4.1
16	0	–	–	–	–	–	–	2	–	–	–	1	1	–
Sum	255	21	88	73	55	18		69	1	20	17	20	11	

involved. Such children usually have genetic short stature (there is a strong family history of short stature) or constitutional delay in development, a condition to be discussed in more detail later. Height well below the third percentile, for example, a 12-year-old with a height average for a 9-year-old or less, should be an indication for medical referral.

The unusually tall male is rarely viewed in our society as a potential medical or psychological problem. Indeed, medical causes for overgrowth are exceptionally rare but should be kept in mind. A genetic disorder, Klinefelter's syndrome, tumors of the anterior pituitary resulting in excessive growth hormone production, and any one of several causes for sexual precocity may lead to excessive or early rapid development.

Unusually tall girls not infrequently come to medical attention because of psychological concerns. Almost invariably such girls are healthy, do not have glandular problems, and are tall because of their genetic make-up. Early bone fusion may be induced by therapy with large doses of estrogen, thus diminishing adult height somewhat. The therapy is not without some undesirable side effects and should not be considered unless the projected adult height exceeds six feet.

Alterations in Sexual Development

As indicated earlier, the normal range in the timing and progression of sexual maturation is great. The great majority of adolescents who seek medical advice because their rate of progression differs from that of their peers are found to be healthy young people without glandular or other medical problems. That is not to say, however, that therapy may not be appropriate in some of these cases.

Sexual precocity is the attainment of sexual maturity at an age earlier than that considered to fall within the normal range. Most investigators would consider menarche in females or achievement of mid-adolescence (Tanner

stage 3) in males prior to 9 years of age as abnormally early. Such children deserve complete medical evaluation to rule out pathological conditions such as tumors of the hypothalamus or gonads. Most of these children have an early "turn-on" of the hypothalamic-pituitary-gonadal axis without identifiable pathology. Expectation for future health is excellent, but psychological counseling is needed early.

Delay in sexual maturation is a common adolescent complaint. The absence of any secondary sexual characteristics at 15 years of age exceeds the upper limits of normal distribution and should be an indication for evaluation. In most cases, the young people or their parents have already obtained medical advice sometime prior to 15 years.

Young people with delayed sexual maturation may be conveniently divided into those with and those without associated alterations in physical growth. A most frequent type of referral to the pediatric endocrinologist is the teenaged boy who is both short and without sexual development. A typical example would be the 14-year-old who is the size of the average 10-year-old and who has no evidence of sexual maturation. The young man and his parents are usually extremely concerned about both problems. The boy is beginning to develop psychological problems such as avoidance of his peers, particularly in athletic or social situations. A request for medical excuse from gym classes is frequent, particularly if showering is required. Academic problems may develop. Most of the boys in this category have what is termed constitutional delay in growth and maturation. This condition is more common in males and frequently occurs in families. It is not an endocrine disease, but rather a biological variant of normal development. Such individuals will achieve on their own full normal sexual development and adult height in the low normal range. However, the timing may be 2-4 years behind their peers. Hormone therapy to stimulate development may be highly appropriate in selected individuals in this category. Short girls with sexual delay must be evaluated for a common chromosomal disorder known as Turner's syndrome. Unusually tall children with eunuchoid proportions (unusually long arms and legs) and sexual delay should be evaluated for genetic or chromosomal disorders.

Abnormal delay in sexual development in the teenager of normal height may be a result of pathological conditions in the hypothalamus, pituitary, or gonads. Appropriate evaluation can usually define the problem. Replacement therapy with sex steroids can induce full secondary sexual development.

Related Problems in Sexual Development

A most common complaint of the teenaged girl relates to irregularities of the menstrual cycle. The problems include prolonged intervals between periods, excessive bleeding, scanty bleeding, and periods at more frequent intervals than once monthly. The establishment of regular, predictable menstrual periods of 5-7 days in length at intervals of 26-30 days takes 12-18 months after menarche in most girls. The initial cycles are usually anovulatory. That is, no ova are produced and pregnancy is not possible. Anovulatory cycles are, in the majority of girls, painless. The onset of cramping or other complaints of discomfort associated with menses in a girl who has previously been symptom-free is a good indication of the establishment of ovulatory cycles.

Gynecomastia (breast development) in the adolescent male occurs almost universally. Slight to modest enlargement of the breasts occurs as a result of hormonal changes during the phase of most active sexual development. Some

boys may misinterpret this normal phenomenon and question their masculinity. In rare cases marked gynecomastia may occur, producing extreme embarrassment and avoidance of any situation that might lead to exposure of the breast. Surgical removal of the excessive breast tissue can, and should, be accomplished in these boys.

In recent years, as a byproduct of the intense competition of our high school athletic programs, there has arisen a highly deplorable practice of administering testosterone injections or "anabolic steroids" to male athletes. The objective is to stimulate increased growth and strength. Although there may be some initial positive response to this approach, the ultimate effect is to fuse the long bones earlier than normal, possibly decreasing the athlete's adult height by 1-3 inches. The practice can only be condemned.

Application of Developmental Information in the School System

School personnel working in junior high schools and middle schools, and to a lesser extent high schools, are confronted daily with the fact that within the same classroom are students who may vary from preadolescent to fully sexually mature. Differences of 6-8 inches in height and 40-60 pounds are not uncommon. The physical variability is further confounded by remarkable differences in emotional maturity, attentiveness, interest and intellectual ability. One might ask whether this extraordinary variability makes a difference and if so, can or should anything be done to alter it.

In a series of studies by Jones et al, two groups of high school males were evaluated for personality characteristics, school achievement, extra-curricular activities, etc. and then followed up 20 years later. The boys were the upper and lower 20 percent of the skeletal age distribution in a normal public school sample (i.e. the groups represented early and late maturers). They found that "those who are physically accelerated are usually accepted and treated by adults and other children as more mature. They appear to have little need to strive for status. From their ranks come the outstanding student body leaders in senior high school. In contrast, the physically retarded boys exhibit many forms of relatively immature behavior. This may be in part because others tend to treat them as the little boys they appear to be. Furthermore, a fair proportion of them give evidence of needing to counteract their physical disadvantage in some way—usually by greater activity and striving for attention, although in some cases by withdrawal."

Analysis of results of the Thematic Apperception Test (TAT) in this population of boys at 17 years of age resulted in the following observations. The later developing boys were more likely to have negative self conceptions, feelings of inadequacy, strong feelings of rejection and dominance, prolonged dependency needs, and rebellious attitudes toward parents. Follow-up evaluation at 33 years of age showed persistence of many of the personality characteristics of adolescence, despite the fact that there were now no differences in physical attributes, level of education, marital status, or number of children between the early and late maturing boys. The early maturers continued to be perceived as physically more attractive, relaxed, poised, and matter-of-fact. They ranked high on measures of "good impression" and "socialization." Vocationally, the early maturers were much more advanced than their slower maturing peers, several making rapid progress as junior executives.

These studies stress the importance of maturational level on the development of personality characteristics during adolescence and the persistence of these characteristics into adult life.

The problems of variability in rate of growth and sexual maturation are most dramatically accentuated in the area of athletics. The development of school teams based on age and grade placement almost invariably means that the small, late-maturer is quickly relegated to non-competitive status. Team structure based upon both age and size, such as the "Little Leagues," would appear to be an effective approach, but in fact, it has not been. Because of the intense focus upon winning, the least accomplished performers are usually eliminated from the sports program before their skills can develop.

Is it possible, in the ordinary school setting, to obtain reliable information on growth and maturation? It is! Annual measurements of height and weight in the pre-teen years, accurately plotted on standardized growth grids, provide the background for sexual staging during adolescence. With the approval of the parents, enthusiasm of the school administration, and the interest and cooperation of a few physicians, Tanner grading can be readily accomplished.

How could the information so obtained be utilized? Obviously, children at the extremes should be considered for medical referral to rule out specific pathological conditions. More importantly, curricular revisions could be made, allowing young people of similar developmental status to share some educational and physical opportunities. Preventive counseling could be directed toward those young people with developmental delay to prevent the negative personality characteristics observed above.

Will curricular changes based on developmental information significantly affect the future course of the student in either academic, physical, or emotional terms? This writer is not aware of any serious long-time effort to apply developmental information to the development of curricular and athletic programs for the adolescent. It seems highly likely that beneficial effects will acrue. It is hoped that innovative school systems will begin embarking on such a program with adequate controls and observations so that the effectiveness of the program can be documented.

References

Reiter, E. O. and Root, A. W. *Hormonal changes in adolescence, Symposium on Adolescent Medicine.* Med. Clin. of N. A. *59:* 1289, 1975.

Tanner, J. M. *Growth at Adolescence.* Ed. 2, Oxford: Blackwell Scientific Publications, 1962.

Greulich, W. W. and Pyle, S. I. *Radiographic atlas of skeletal development of the hand and wrist.* Stanford University Press. Stanford, Calif., 1964.

Frisch, R. E. Critical weight at menarche, initiation of the adolescent growth spurt and control of puberty. *The Control of the Onset of Puberty.* Grumbach, M.M. Grove, G. D., and Moyer, F. E. (eds). John Wiley and Sons, New York, 1974.

Tanner, J. M. Sequence and tempo in the somatic changes in puberty, ibid.

Land, G. M. van'T and Hass, J. H. de. *Menarche—leeftijd in Nederland.* Ned. Tydschr. Geneesk. 101:1425, 1957.

Marshall, W. A. Growth and sexual maturation in normal puberty. *Clin. Endo. and Metab.* 4:3, 1975.

Nankin, R. R., Sperling, M., Kenny F. M., Drash, A. L. and Troen, P. "Correlation between sexual maturation and serum gonadotropins: comparison of black and white youngsters." *Amer. J. Med. Sci.* 268:139, 1974.

Jones, M. C. and Bayley, M. Physical maturing among boys as related to behavior. *J. Educ. Psychol.* 41:129, 1950.

Mussen, P. H. and Jones, M. C. Self-conceptions, maturations and interpersonal attitudes of late- and early-maturing boys. *Child Development* 28:243, 1957.

Jones, M. C. The latter careers of boys who were early- or late-maturing. *Child Development* 28:113, 1957.

Middle School Developmental Age Grouping: A Needed Consideration

Donald H. Eichhorn

We may consider students in different ways in relation to the educational process. The most prevalent student base is, of course, the graded concept, specifically grades 6, 7, and 8. Without a doubt, this has been and is the overwhelming organizational construct for middle school education.

It is characterized by sameness, i.e. conformity to the grade. Educators talk about grade 6 or 7 or 8 as entities. Thus, students in grade 6 are taught at level 6 and students above or below sixth grade level are treated as exceptions, i.e. differing from the norm. Students are judged in reference to the graded norm. Instructional materials such as textbooks, audio-visual materials, and curriculum units are developed and used in relation to the norm. Thus, in seventh grade concepts are to be acquired by students because these learners have been in school seven years. Early in the middle school movement, heated debates occurred concerning which grades belonged in the middle school; it is a fine question, but irrelevant.

The point is simply that we have devised a total educational rationale and process founded on a totally erroneous premise. It is an illogical syllogism comparable to the following:

The sun is light
Feathers are light
Therefore
The sun is made of feathers.

Or as applied to middle schools:

There is a grade seven
Students are in grade seven
Therefore
These students are seventh graders.

The fact is the only comparable factor involved with seventh graders is their assignment to seventh grade. Faulkner[1] implies why this criterion is simplistic:

> We are accustomed to describing an individual acquaintance by some physical characteristics and his chronological age. This last factor is supposed to supply the final unmistakable clue. Yet if the individual is described as a 13 year old boy, human biologists are the first to be at a loss. Since there is such a very, very wide variation among normal children in the age of onset of the adolescent growth spurt, and since the period is one of such rapid growth, it is little wonder that we are lost. The thirteen year old may be of small stature and cherubic appearance, or he may sport a mustache and be 6 feet tall and in demand as a basketball player. The morphological, physiological, educational and social implications of this difference are manifestly important. In this field of

Donald Eichhorn is Superintendent, Lewisburg Area School District, Lewisburg, Pennsylvania.

human development, we must therefore, consider another age process: maturational or developmental age.

In a joint research study conducted with Dr. Allan Drash, Professor of Pediatrics in the School of Medicine, University of Pittsburgh and Children's Hospital of Pittsburgh, the writer has had the opportunity to study extensively the impact of biological maturation on the transescent learner. It is my conclusion that unless we embark on a program of developmental age grouping of students rather than graded grouping of students, we will continue to go in circles in our quest to improve education at the middle school level.

Research clearly points out the high correlation between learning and maturation, as well as between maturation and social-emotional growth and problems. Strang[2] points out:

> Facts about the physical growth preceding and following puberty are important for a number of reasons. Bodily changes, especially if sudden, change the adolescent's body image and self-concept; he may now see himself as an adult with adult privileges and responsibilities. Biological changes give rise to physical sensations; these are translated into emotional states which may be expressed in social behavior. Slow or rapid growth, unevenness of growth, or abnormalities of growth may affect an adolescent's total development.

While middle school educators readily acknowledge this relationship, their response is inadequate and, in effect, contrary to the direction indicated. By attempting to formulate a program of gradedness, the diverse social-emotional levels of early adolescence are subordinated to the institutional goal of sameness.

Many scholars, over the decades of junior high and middle school education, have alluded to this problem but educators have not recognized the import of their comments. As early as 1904, Hall[3] said, " . . . The range of individual differences . . . in all physical measurements and all psychic tests increase."

Havighurst[4] stated, "The period from twelve to eighteen is primarily one of physical and emotional maturing." Thompson[5] concluded:

> As children become older, individual differences in abilities are magnified. Different rates of psychological growth result in larger absolute differences in achievement levels as children increase in age. This increasing divergence in abilities with advancing age makes chronological age by itself a poorer and poorer criterion for approximating the maturational-experimental level of older children."

The Boyce Medical Study[6] analyzed 487 middle school students in terms of biological maturity. Drash reported the results in terms of age and biological maturity. Tables 1 and 2 describe these results.

Table 1

Range in Years for Boys Per Classification Level

	I	II	III	IV	V
Range in Years	10.8-14.1	10.7-13.8	11.1-14.2	11.8-14.9	13.2-13.8
$\bar{M}$ in Years	11.98	12.07	12.78	13.07	13.49
No. of Boys	37	108	55	24	8
%Age	16	46	24	10	4

Table 2

Range in Years for Girls Per Classification Level

	I	II	III	IV	V
Range in Years	10.1-12.1	10.1-13.7	10.8-13.7	11.5-13.9	11.1-14.0
M in Years	11.2	11.8	12.4	12.11	12.5
No. of Girls	22	88	74	55	18
% Age	9	34	29	21	7

The divergence of biological maturity of these middle school students in relation to chronological age is obvious. There were 14-year-old boys who were found to be in Classification Level I, which indicates no secondary sexual development present, while there were 11-year-old girls placed in Classification Level V, representing complete development of secondary sexual characteristics. Thus, there were sixth grade girls in this group who were physically, emotionally, and socially young adults while there were eighth grade boys who were, in fact, still complete children.

The Boyce Study clearly pointed out the need to develop a more compatible organizational approach in relation to the characteristics of middle school children. In a similar way Wattenberg[7] said earlier:

> Usually junior high teachers are left to find their own techniques for coping with the extreme heterogeneity of their classes . . . Yet from the viewpoint of a psychologist one can ask why there has been so little direct study of this aspect of the junior high, why there has been almost a complete neglect of grouping problems as a subject for scientific study . . .

Drash[8] commented from a medical perspective:

> Will curricular changes based on developmental information significantly affect the future course of the student in either academic, physical, or emotional terms? . . . It seems highly likely that beneficial effects will accrue. It is hoped that innovative school systems will begin embarking on such a program . . .

In the past, much emphasis has been placed on approaches such as continuous progress, individualization of instruction, and personalization of experiences. For the most part, these encouraging approaches have been implemented in the graded framework. As in the case of many exciting innovations, it is a case of putting "new labels on old bottles." In effect, there is a contradiction i.e., nongraded instruction in a graded framework.

Psychologists and physicians have, on occasion, pointed out the significance of growth-related concerns with the educational process.

Rabinovitch[9] commented on what often occurs as a result of growth complications. He stated, "The commonest single immediate cause for referral to our guidance clinics is behavioral, academic, or social difficulty experienced by children at school."

Tanner,[10] an eminent English physician, in a similar way commented on the need for teachers and schools to consider growth patterns in the educational program. He wrote:

> The assessment of developmental age by medical means, may be of value to the teacher . . . an assessment of physical maturity is regarded in many countries as an essential part of the examination of a child referred to the child health service because of behavior disorders, unexpected educational failure, chronic ill health or sub-standard growth. But the

formal determination of physical maturity in a few children is perhaps less important than the general realization amongst teachers of the existence and effects of individual differences in tempo of growth, and the planning of the educational system to accommodate them.

This writer[11] has defined the middle school rationale in terms of the concept of transescence. Transescence is defined as:

> . . . the state of development which begins prior to the onset of puberty and extends through the early stages of adolescence. Since puberty does not occur for all precisely at the same chronological age in human development, the transescent designation is based upon the many physical, social, emotional, and intellectual changes in body chemistry that appear prior to the puberty cycle to the time in which the body gains a practical degree of stabilization over these complex pubescent changes.

Physically, the youngster moves from a stage of sexual impotency in elementary school to the point in adolescence of complete sexual potential. Mentally, stage-level pyschologists indicate that children move from an operations stage in which intellectual processes center on the concrete to an adolescent stage of formal operations, which provides the person with the mental capability to think in the abstract. Socially, the youngster develops from a point of dependency on the family for values and security to a point in adolescence in which he finds a comparable dependency in the peer groups.

Developmental Grouping in Upper St. Clair*

Educational programs, to be effective, must reflect the nature of transescence. Learning may be considered in two dimensions; first, the educational program, i.e. the curriculum, learning strategies, materials, and evaluations, are all aspects of the efficiency of learning. Second, those conditions that deter learning must be eliminated or at least minimized. These include problems related to maturation, emotional disturbances, ill health, et. al. Educators cannot successfully accomplish the first dimension without consideration of the second dimension. The learning process is not an isolated scientific endeavor unrelated to the child for which it is intended. It is an integral process involving the child and the child's status. Medical practitioners cannot treat people suffering from ill health in a manner divorced from the conditions causing the problem, and in the same vein, educators must consider learning.

Developmental grouping is suggested as a means of minimizing those aspects of a middle school student's status brought on by growth factors in an attempt to maximize learning.

The concept of developmental grouping has been employed in the Upper St. Clair, Pennsylvania middle schools since September, 1969. The results have been impressive; however, it should be strongly pointed out that the following results represent only *one* school district's experience. The results are as follows:

1. Achievement, as measured by a standardized test, significantly improved. There was an average 5-month-per-student improvement in standardized achievement testing in the 1969-70 school year. This escalation has essentially remained in the succeeding years. A second indication of

*Upper St. Clair is a suburban school system located in southwestern Pennsylvania 10 miles from Pittsburgh, Pennsylvania.

achievement in the basic skills came as a result of Upper St. Clair's test results on the Educational Quality Assessment examination which was administered to 62 middle schools in Pennsylvania during the 1972-73 school year. The Pennsylvania Department of Education reported the following basic skill results:

	Boyce Middle School	*Ft. Couch Middle School*
Verbal	98% ile	97% ile
Mathematics	89%	96%

2. Self-concept (esteem) as measured by the 1972-73 Pennsylvania Educational Quality Assessment is indicative of the success of the affective program. The Department of Education reported the following results for Upper St. Clair's Middle Schools:

	Boyce Middle School	*Ft. Couch Middle School*
Self Esteem	90% ile	99% ile

The major steps taken in the Upper St. Clair Schools in the initiation of developmental grouping were as follows:

1967-69	Faculty-administrative discussion groups decided, based upon research, to initiate developmental grouping.
1969	The Boyce Medical Study* was conducted by Dr. Allan Drash, Director of the Clinical Study Center of Children's Hospital, Pittsburgh, Pa., and a team of medical specialists. The purposes of this study were: 1. To determine the level of biological maturation for each student by medically examining four hundred eighty-seven students; and, 2. To evaluate the medical results and to assess the implications for educational program. The results of this study reaffirmed the decision to initiate developmental grouping.
1969-70	Subjectively, students were developmentally grouped into three units which corresponded to pre-pubescence, emerging adolescence, and adolescence. The data from the Boyce Medical Study confirmed the validity of the subjective groups.
1972	A social maturity and mental maturity index was developed by the local faculties as a means of placing students developmentally.
1973-79	Program has continued with refinements.

By adopting the developmental grouping process, the Upper St. Clair Middle Schools have been able to implement other aspects of program more effectively. Curriculum rationale and learning strategies particularly have been altered.

Curriculum rationale has been a major area of concern for middle school educators. Toepfer[12] has historically analyzed the curriculum problem facing middle school educators. As a result he stated:

> This legacy of reshuffling of form has not given adequate consideration to the specific educational substance of early secondary education. Such

*For more details see Boyce Medical Study in ASCD—ELI Multi Media Package. Educational Leadership Institute, Springfield, Mass.

changes have been based largely upon administrative expedience with minimal curricular organization for instructional improvement. As a result, the clientele of early adolescent learners in early secondary schools probably has experienced less discrete definition of basic curricular experience than those at either the elementary or high school level. This definition should become a primary operational task of the middle school concept.

Thus, once the developmental grouping concept was accepted by Upper St. Clair, we discovered significant curriculum and learning strategy problems with the traditional junior high school model. For example, if the social studies curriculum is tied to a graded concept, i.e. Latin America in grade 6, World Cultures in grade 7, and U. S. History in grade 8, one finds students in a developmentally grouped unit who theoretically must have three different courses in the same class. A similar problem exists in the graded curriculum in science, mathematics, and language arts. Thus, it is apparent that the graded curriculum and developmental age grouping are relatively incompatible; conversely, the concept of continuous progress and developmental age grouping complement each other.

In the case of learning strategies, developmental age grouping facilitates individualized strategies and deters group-graded instruction. In the grade level grouping process, the traditional learning strategies of covering material, presenting graded content, and conducting group lectures seem appropriate. Again, the developmental age grouping process enhances continuous progress strategies.

Summary

Education of middle school students has long been founded on the principles of physical, social, and cognitive uniqueness. Virtually all school districts' rationales that are used to substantiate educational programs cite this principle as a reason for the development of middle school education in their respective districts. It is indeed a logical and proven foundation for this level of education.

It is time in middle school education that we seriously consider developmental age grouping as fundamental and begin to develop educational programs that have a logical base. The subsequent impact on curriculum, learning strategies, organization, and climate for instruction will increase the effectiveness of middle school education.

References

[1]Faulkner, Frank, M.D. *Human development.* Philadelphia: W. B. Saunders Co.

[2]Strang, Ruth. *The adolescent views himself, a psychology of adolescence.* New York: McGraw Hill Co., 1959, 209.

[3]Hall, G. Stanley, *Adolescence, Volume I.* New York: D. Appleton and Co., 1904, XIII.

[4]Havighurst, Robert. *Developmental tasks and education.* New York: David McKay Co., Inc., 1952, 33.

[5]Thompson, George G. *Child psychology.* Boston: Houghton Mifflin Co., 1962, 13-131.

[6]Eichhorn, Donald, The Boyce medical study, *Educational dimensions of the emerging adolescent learner,* ed. Neil Atkins and Phillip Pumerantz. Washington, D.C.: A.S.C.D. and Educational Leadership Institute, 1973, 24.

[7]Wattenberg, William, The middle school as one psychologist sees it, *High school journal,* December, 1969, 164-171.

[8]Drash, Allan, Variations in pubertal development and the school system: A problem and a challenge, *Transescence: The journal on emerging adolescent education,* IV, 1976, 25.

[9]Rabinovitch, Ralph D. Reading and learning disabilities, *American handbook of psychiatry*, Silvano Arieti, ed. New York: Basic Books, Inc., 1959, 857.

[10]Tanner, J. M., *Education and physical growth*. London: University of London Press, Ltd., 1961, 3.

[11]Eichhorn, Donald H. *The middle school*. New York: The Center for Applied Research on Education, Inc., 1966, 3.

[12]Toepfer, Conrad F., Jr. Curricular imperatives for the middle school, *New York School Study Council Quarterly*, April, 1969, 18.

Brain Growth and Cognitive Functioning

Herman T. Epstein

My work with humans derives its working hypotheses from my finding that, postnatally, the human brain grows in weight (and volume) mainly during five periods, which are 3-10 months, and 2-4, 6-8, 10-12+, and 14-16+ years. About 85 percent of all children fit into this pattern.

The most important biological details of the brain growth follow from the fact that cell replication (as measured by DNA net synthesis) ceases by about age 18 months. Therefore, the last four growth stages of the brain take place without any increase in the *number* of brain cells of all kinds. This size increase is accounted for by a very substantial increase in protein per brain. For neurons this protein increase would be a manifestation of elongation and branching of axons and dendrites, implying a corresponding increase in the number of interconnections (synapses) among neurons. Therefore, each of the last four brain growth stages is expressed in a substantial increase in the complexity of the neural networks, and this should, corespondingly, express itself functionally in a substantial increase in the complexity of the thinking processes of the brain.

There are experimental data directly supporting the biological inferences listed above. The brain weight growth data are augmented to the point of being scientific fact by the use of the experimentally demonstrated relationship of brain weight to the cube of the head circumference during the entire period from birth to brain maturity (size-wise) around age 17 years. The ample data on head circumference growth show stages at the ages cited above for brain weight. The data on percent of EEG energy found in the alpha range (8-13 cps) show a remarkably large increment pattern just at the ages of the brain growth stages; thus we know that, in terms of connection, the neural networks are changing significantly at these stages. Therefore, it is likely that the indicated increases in synapse number and network complexity actually occur at the ages given above.

We next have to check whether, indeed, there is a parallel of brain growth stages with presumptive stages of intellectual functioning. This turned out to be not as difficult to demonstrate as I thought at the start of the work, because there are ample data on intelligence development, especially coming from the work of Piaget and his associates. Their findings may be summarized as showing the existence of four main stages of development:

I. Age 0-1 year ..... Motor state
II. Age 2 years ..... Sensorimotor stage
III. Age 6-7 years ..... Concrete operations stage
IV. Age 10-11 years ..... Formal operations stage

It can be seen that there is a brain growth stage at the onsets of the Piaget stages, whose ages are as classically given by Piagetians. Although many investigators challenge the age-linkage of these Piaget stages, recent evidence shows that the Piaget stages are more firmly linked to age than supposed even

---

Herman Epstein is Professor of Biophysics, Brandeis University, Waltham, Massachusetts.

by the Piagetians themselves. It is important to note that the presumptive correlation of brain growth stages and Piaget stages requires a prediction that a new Piaget stage will be found corresponding to the fifth (and last) brain growth stage around age 15 years. Beginning in 1975, Arlin has shown appreciable evidence for a fifth Piaget stage, and her most recent data place the onset age as between 14 and 16 years, precisely as predicted.

The natures of the Piaget stages are such that there is a qualitative change in mental functioning at each of the onset ages, as would be expected if there is a very significant increase in neural network complexity.

A question left open by both the Piagetians and by the present studies asks why it is that, while no child shows the onset of a Piaget stage earlier than the ages given, not all children manifest the new stage at such ages. Some only manifest the new stage very much later. It turns out that data on cognitive levels supply additional linkage of intelligence and brain growth without explaining the lag in manifestation of stages at the earliest ages. Piaget and Inhelder found it useful to separate each stage into two levels so that children are grouped according to whether they have manifested just the onset of the new stage or have reached a level of mature expression of the stage. Thus, they speak of children at the onset of concrete operations and others at the mature concrete operations level. Similarly, children may be at the onset of formal operations or show mature formal operations. A fifth level is that of children not showing any systematic thinking at all; they are said to be pre-operational.

It is then possible and useful to study the development of children in terms of these five levels, and it has been found, mainly by Shayer and his associates in England, that the percentages of children showing mature concrete operations or higher levels increase only at the ages of the brain growth stages. Thus, there is a strong linkage of level change to the appearance of new complexity in the neural networks. If this were to hold rigorously, it would let us infer that children who don't manifest some Piaget stage at the earliest possible onset age will never reach the highest intelligence level theoretically possible. If this turns out to be correct, the challenge to all educational strategies would be to increase the likelihood that each child would show the Piaget stages at the classical onset ages.

This way of thinking leads to emphasizing the need for characterizing every child according to cognitive level as defined above. This makes sense anyhow, for there seems to be no alternative in planning educational strategies to the finding out of where the child is cognitively and then helping the child maximally by arranging instruction to be in the mode of cognition in which the child finds itself. A study of the literature gives us the percentages of children in the various cognitive levels at every school age; at every age there are at least two independent studies giving similar percentages. And, it has been possible to find evidence that the distribution of percentages is quite similar in all Western countries. The data are in Table I.

The matching of instructional tactics to the thinking levels and styles of the children would seem to be the first task of any educational strategy. This matching is the basis of the experimentation we are designing and wish to test.

Some general aspects of strategy follow from the simpler facts about stages. For example, the brain growth hiatus between ages 12 and 14 years covers the junior high school, so we predict little increase in intellectual abilities during that period. The data in the table reveal that, indeed, only a

Table I.

Percentage of individuals age 5-18 attaining various cognitive levels.

AGE (YEARS)	Pre-Operational	Concrete Onset	Concrete Mature	Formal Onset	Formal Mature
5	85	15			
6	60	35	5		
7	35	55	10		
8	25	55	20		
9	15	55	30		
10	12	52	35	1	
11	6	49	40	5	
12	5	32	51	12	
13	2	34	44	14	6
14	1	32	43	15	9
15	1	14	53	19	13
16	1	15	54	17	13
17	3	19	47	19	12
18	1	15	50	15	19

small minority of children could have shown any change in level during the 12-14 year period.

Furthermore, the table data at ages 12, 13, and 14 years suggest that 76 percent of children will sit through three consecutive years of being unable to handle material presented at the level of formal reasoning. It is known that most of the material prepared for junior high schools uses the level of formal reasoning. It is, therefore, possible that such children are "turned-off" by receiving many inputs at that level. We have preliminary data on this possibility.

First, it has been shown by Shayer and his associates that even in the top 20 percent of children at age 14 years, some 30 percent do not manifest formal operations. This is not surprising, since IQ is related mainly to *speed* of learning, while cognitive level is related to *style* of learning. Thus, we are led to predict that close to 30 percent of high IQ children should be subject to the "turn-off" phenomenon. This has been tested by my associate, Professor Toepfer, who studied the later school histories of 1,700 children arriving at junior high school with IQ's of 120 or higher. These gifted children should have few failures, yet the data show that 23 percent of them show a failure pattern beginning on entry into junior high school and continuing through senior high school. The numbers 30 percent and 23 percent are not importantly different in this calculation. Of course, without testing and following the individual children, we cannot prove that they represent the same children; this kind of information is among the goals of the experimentation we propose to do.

Last year, Professor Toepfer and I carried out a first pilot program along the lines indicated by the brain growth stage data. Since we postulated that children at junior high school age cannot accept novel intellectual challenges, we reduced the presumptively harmful challenge by removing the children from school two days per week; they were placed in community service work such as that found in day-care centers, homes for the aged, etc. Apart from the traditional effects of novelty, which were found in abundance, there were clear indications of positive effects in that average grades rose substantially. This situation held throughout the experimental period of January to June, 1978.

This program has to be repeated with matched controls and with ample pre- and post-testing, as well as with additional controls to enable us to learn if the improvements were actually due to the factors we proposed rather than

to other factors. In addition, we want to run a parallel set of experiments in which children are grouped according to cognitive level in both the experimental and control groups to permit an inference about the effectiveness and conditions for cognitive-level groups.

Cognitive Growth and Development of the Middlescent Learner

Glenn Maynard

At the awkward age of no longer being a child and usually short of being classified as an adolescent, the individual in the middle has been tagged with a variety of names. Girls and boys, age 10 to 14, are sometimes referred to as transescents, youth, early adolescents, emerging adolescents, or middlescents.

Perhaps the dilemma of a name is indicative of several similar problems in the education of the middlescent learner. One such problem is when to call a school in the middle a junior high school and when not to call it a junior high school but a middle school.

Another problem relates to the question of teachers—what should be the teacher preparation program for middlescent learners? Do we want teachers with elementary preparation or with secondary preparation in subject matter? Or, is there a distinct and discrete teacher preparation program for teachers of middlescents? How about the certification for these teachers? Are there certain characteristics of teachers for this age learner that we want to emulate? Or, does the middle school become the "dumping ground" of unsuccessful or untried secondary teachers as so often seems to happen in the junior high school? Or, should it be those elementary teachers who seemed to be quite successful in "handling" the older boys and girls in the elementary school?

And, how should the middle school be organized? Fifth and sixth grades self-contained with seventh and eighth (and maybe ninth) with an increasing amount of secondary-type scheduling? Or with the team teaching approach (hopefully with team planning along with it)? Do we promote the concept of the core curriculum?

And what of exploratory activities? How many, when offered, who can choose, and how often may they choose? What of the guidance activities in the middle school? Who should be responsible—the classroom teacher or a guidance specialist or a group of teachers in a team?

What do we teach? What should be the curriculum for the middlescent? If we follow the plan of most textbook publishers (and they respond that they only supply what the education profession demands) it will be a spiral curriculum with each grade level having more difficult concepts to master than the previous grade level. Or do we branch out and follow one of the "new" curricular approaches presented by individuals, organizations, or textbook publishers? How seriously have we studied what we are teaching at the middle school level? The other problems I have mentioned earlier seem to have received most of the publicity. Of all ages, the middlescent age has had the least research in terms of psychology, medicine, and sociology, as well as professional education. Fortunately, that body of research in these areas has increased dramatically in the past ten to fifteen years.

Glenn Maynard is Professor of Education, Kent State University, Kent, Ohio.

Within the last two or three years some very exciting research and reporting of research focusing on the brain has taken place. The work of Herman Epstein has provided some dramatic breakthroughs in our knowledge of how the brain grows and how it grows in a regular pattern, although the regular pattern is quite irregular in the spurts and plateaus.

The very exciting scientific data presented by Dr. Epstein has a great many educational implications, particularly for those of us interested in the education of the middlescent learner.

While Epstein's work is definitive, the implications for education are based more on assumptions than on scientific fact. While the work of Epstein and Toepfer, and some few others at this point, has produced a beginning body of research knowledge using the brain growth periodization concepts, much more research is necessary.

One of the assumptions is that since there is a brain growth hiatus or plateau between the ages of 12 to 14 (generally grades seven and eight) the data (Table I) suggest that 80-88 percent of these middlescent students will not be able to handle materials presented at the level of formal reasoning—and those few who can handle it will be at the onset stage rather than the mature stage of formal reasoning.

Another assumption is that there is a sex differentiation. It is speculated that girls may reach the onset level of formal reasoning one or more years earlier than will boys. If research proves this point, we may be holding back girls who are ready for formal reasoning while waiting for the boys to mature in thinking skills. This does not appear to be too serious on the surface. However, a further speculation is that if educators ignore the readiness of the girls for formal reasoning, the girls may be "turned off" and not be able to be "turned on" later.

Still another assumption is that if, indeed, approximately 85 percent of the students in middle schools are at the concrete level of operation and would be hard pressed to accept new cognitive concepts at the abstract or formal thinking level, we should use this period of brain growth hiatus to strengthen the skills that have already been acquired.

The testing of these assumptions, under the guidelines of Professors Epstein and Toepfer, has been started even though in a relatively small way. Further research is in the planning stage and soon, we hope, we will have scientific research completed to verify these assumptions.

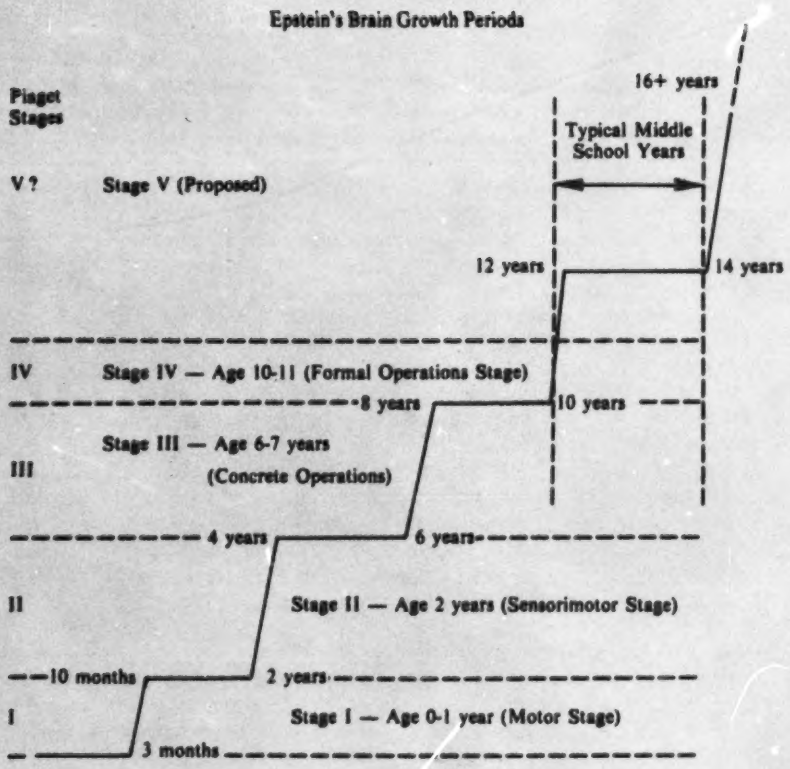
Table I

Per cent of students reaching various Piagetian stages at given age levels

AGE (YEARS)	PRE-OPERATIONAL	*CONCRETE ONSET*	*CONCRETE MATURE*	*FORMAL ONSET*	*FORMAL MATURE*
5	85%	15%			
6	60%	35%	5%		
7	35%	55%	10%		
8	25%	55%	20%		
9	15%	55%	30%		
10	12%	52%	35%	1%	
11	6%	49%	40%	5%	
12	5%	32%	51%	12%	
13	2%	34%	44%	14%	6%
14	1%	32%	43%	15%	9%
15	1%	14%	53%	19%	13%
16	1%	15%	54%	17%	13%
17	3%	19%	47%	19%	12%
18	1%	15%	50%	15%	19%

Figure I

Epstein's Brain Growth Periods



What may be done while this research is underway? Teachers of middlescent learners may find it possible to meet the needs of the youngsters in their charge by using the test for formal or abstract thinking provided in Robert Sund's publication *Piaget for Teachers*. Cognitive mapping techniques to discover the best learning/teaching styles for individual learners can be used.

Further, we can organize middle school education in such a way that it becomes a personal experience rather than an impersonal task for both learners and educators. The sharing of responsibilities among a cadre of teachers for the maximum cognitive, emotional, physical, and affective growth and development of middlescent learners is a possibility with cooperation.

A very careful analysis of what is being taught can be carried out. Do the textbooks, courses of study, curricular modules meet the needs of the middlescent? Do these youngsters need fewer new concepts in depth rather than many new concepts rather hastily "covered"? Could these middlescents profit more from their schooling by wider experience in using the concrete thinking skills they have acquired rather than being presented abstract concepts that they are not able to develop because of brain growth periodization?

Finally, the concept of "ease of learning" is of great moment with middlescent learners. Since 1957 and the "Age of Sputnik" we educators (admittedly under considerable pressure from the scientific community, parents, and even the federal government) have attempted to make our educational programs more rigorous to meet these pressures—usually in the form of pushing subject matter downward. Experience should tell us that this is not successful, and in the near future, brain growth periodization may give us scientific data to support this experience.

Selected Bibliography on Cognitive Development for Middle Grades Education

Prepared by Glenn Maynard and Conrad F. Toepfer, Jr.

Arlin, Patricia Kennedy. Cognitive Development in Adulthood: A Fifth Stage? *Developmental Psychology II* (1975), No. 5

Behrens, Herman D. and Maynard, Glenn, Editors. *The Changing Child: Readings in Child Development* (Glenview, ILL.: Scott Foresman and Co.), 1972.

Elkind, David. *A Sympathetic Understanding of the Child Birth to Sixteen* (Boston: Allyn and Bacon, Inc.), 1978.

Epstein, Herman T. *A Strategy for Education* (Oxford: University of Oxford Press), 1970.

_____. A Neuroscience Framework for Restructuring Middle School Curricula, *Transescence: The Journal on Emerging Adolescent Education* V (1977).

_____. Growth Spurts During Brain Development: Implications for Educational Policy, *1978 Yearbook of the National Society for the Study of Education*, Edited by J. S. Chall and A. F. Mirsky (Chicago: University of Chicago Press), 1978.

_____. and Toepfer, Conrad F. Jr. A Neuroscience Basis for Reorganizing Middle School Education, *Educational Leadership* XXXVI (May 1978).

_____. and Toepfer, Conrad F. Jr. Neuroscience Imperatives for Transescent Education, *Michigan Middle School Journal* III (Spring 1978), No. 2.

_____. and Toepfer, Conrad F. Jr. Reorganizing Middle Grades Education, *Education Digest* XLIV (October 1976), No. 2.

Lounsbury, John H. and Vars, Gordon E. *A Curriculum for the Middle School Years* (New York: Harper and Row, Publishers), 1978.

Maynard, Glenn. A Middle School Identity, *Transescence: The Journal on Emerging Adolescent Education* III (1975), 9-12.

Maynard, Glenn. Junior High School or Middle School? *Information and Data Disseminating Service*, Ohio School Boards Association Policy and Program Development, No. 3 (November 1968), 11 pp.

McConnell, Mary. Interdisciplinary Curriculum Materials: Filling the Gap, *Middle School Journal* X (May 1979), 10-11.

Renner, John W., *et. al. Research, Teaching, and Learning with the Piaget Model* (Norman, Oklahoma: University of Oklahoma Press), 1976.

Shayer, M. and Wylam, H. The Distribution of Piagetian Stages of Thinking in British Middle and Secondary School Children, *The British Journal of Educational Psychology* XLVII (February 1978), 62-70.

Sund, Robert B. *Piaget for Educators*. (Columbus, Ohio: Charles E. Merrill Publishing Company), 1976.

Toepfer, Conrad F. Jr. Areas for Further Investigation Suggested by Brain Growth Periodization Findings, *Transescence: The Journal on Emerging Adolescent Education* VII (1979), 17-20.

_____. Curriculum Planning Priorities for the Middle School, *Middle School in the Making*, Edited by Robert P. Leeper. (Washington: Association for Supervision and Curriculum Development), 1974.

_____. Some Operational Problems in Educating Emerging Adolescent Learners, *Educational Dimensions of the Emerging Adolescent Learner* (Springfield, Mass.: Educational Leadership Institute, Inc.), 1973.

Yinger, J. Milton, *et. al. Middle Start: An Experiment in the Educational Enrichment of Young Adolescents* (Cambridge: Cambridge University Press), 1977.

Brain Growth and Higher Level Thinking

Edward N. Brazee and Phyllis E. Brazee

The work of Dr. Herman Epstein in brain growth periodization has had a revolutionary impact on middle school theorists but a very limited influence on middle school teachers. Dr. Epstein's neurological data, which seem to verify Piaget's stages of cognitive development, indicate that much of the instruction at the middle school/junior high school level is too difficult for the students for which it is intended.[1] Dr. Epstein has stated that fully 76 percent of students 12, 13, 14 are unable to benefit from instruction because the instruction is presented at a formal cognitive level while many of the students are at a concrete cognitive level.[2]

Dr. Epstein's data on brain growth during middle school years (10-14) indicates that the brain growth spurt from 10 to 12 years is followed by a plateau or period of no growth from 12 to 14 years. These data are of monumental importance because it becomes very obvious that instruction should be geared to meet the range of cognitive capabilities of each child. Although the importance of such findings cannot be overstated, these are not revolutionary data. Many teachers have known this to be true intuitively. However, this information has not resulted in improved methods of instruction that recognize the range in cognitive levels at the middle school/junior high level. Indeed, children in many middle schools are instructed as if they functioned at the same cognitive level.

Although some work has been done to adapt curricula to meet the different cognitive levels of middle school students, the impact has been very limited. It is essential that schools begin to use this information to gear instruction to multiple levels of understanding as well as to offer attainable challenges that will allow each student to achieve a more formal level of thought when ready.

Because of the slowed brain growth from 12 to 14, Epstein and Toepfer have hypothesized that the schools' emphasis on a continuing cycle of increasingly more abstract learning is dysfunctional. During this plateau period they suggest that a consolidation of previous learning should take place and that previously learned skills should be applied in a realistic setting.[3] Little experimentation along these lines has occurred so we set out to investigate these suggestions.

Focus for the Study

In order to design curricula that meet the range of cognitive levels, it is imperative for each teacher to assess the cognitive level of each student. Current assessment techniques are limited to such pencil/paper tests as the Ankeny/Joyce and the Burney, both of which are heavily science and math content laden.[4]

Because of the seeming inadequacies of existing measures in assessing cognitive level in the areas of language and literature, the researchers devised

---

Edward Brazee and Phyllis Brazee are each Assistant Professor of Education, University of Northern Colorado, Greeley, Colorado.

a set of criteria for rating the cognitive level of students in language and literature. It was hypothesized that the pencil/paper measures were too content bound in math and science to be useful predictors of cognitive functioning in language and literature.

The other important area of the study was concern for identifying kinds of instruction that allowed each student to respond at his or her present cognitive level. Such instruction would provide activities and learning on the concrete level but would also provide for formal level thought. This instruction would also allow the student to be challenged into the next cognitive level when he was developmentally ready.

A danger of finding each student's cognitive level is the typical and overly simplistic instructional response to group or track students according to cognitive level. (i.e. the "concrete" group, the "transitional" group, and the "formal" group.) This might work initially, but it would seem ultimately to limit student cognitive growth. A student who is assessed at the beginning of the year as being a concrete thinker, for example, might be ready for the onset of formal level thought by November, but would remain with other children in the concrete cognitive level because that was his designated group. Therefore, this student would miss the critical point to move on to the next level of cognitive development, especially if reassessment of students did not occur until spring.

Instead, what seems to be needed is an instructional environment that allows each student to participate at his present cognitive level but at the same time interact with students at other cognitive levels. At the present time there seem to be few instructional techniques that could do this. One of the few seems to be the concept put forth by Harold Herber called the Three Level Study Guide.[5]

Specifically then, three questions were investigated:

1. How well can a classroom teacher predict the cognitive level of students based on criteria set by that teacher?
2. What assessment devices are accurate measures for cognitive functioning in language and literature?
3. Will one instructional technique (Herber's Three Level Study Guide) allow students at all cognitive levels to respond, as well as to provide an environment for students to move to the next cognitive level when ready?

Description of Procedures and Findings

Question 1

The first question of the study asked whether arbitrarily designed teacher observational criteria for assessing a student's cognitive level could be validated against examination of student performance in class.

The first step was for the teacher to design a set of observational criteria. This was done in the fall quarter, 1978, after the students had been in school for about two months. The students were then placed into one of three categories by using the teacher's criteria: concrete, transitional, or formal cognitive level. The specific criteria developed by the teacher follow:

CONCRETE
Students who . . .

1. had less independence, more need to have things explained exactly.
2. had inability to go from one task to another without explicit teacher direction.

3. had inability to see relationships between ideas.
4. at the literal level were tied to details in the story.

TRANSITION

Students who . . .

1. had the ability to perform at formal level on some tasks but were consistently inconsistent. These students would perform at all three cognitive levels depending on the task.

FORMAL

Students who . . .

1. had good sophistication of ideas.
2. had the ability to perceive relationships between two ideas.
3. had independence and could perform without constant teacher direction.
4. answered at the interpretive and applied levels of comprehension to go beyond the surface information in reading to relate broad general principles.

Initial teacher rating of 49 students by cognitive level showed 19 students or 40 percent at concrete cognitive level, 14 or 29 percent at transitional cognitive level, and 15 or 31 percent at formal cognitive level.

To assess the validity of the teacher-developed criteria the students were then asked to read a short story from an anthology of short stories, *What Makes A Good Story*, and respond to the following directions in writing:

Directions:

1. Put your name on the line provided; circle the letter of the group you are in (A or B); write the name of the short story on the line provided.
2. Read the story.
3. In the space provided below write a one-half page reaction on the THEME of the story. Consider these questions in your answer.
   "What is the story really about?"
   "What is the author saying in this story?"
   "Why are the events and/or characters strange, unusual or ironic?"

Write your reaction to the story here.

It was assumed that asking for the theme of a story should elicit a formal level response, but that students not at that cognitive level would respond either with simple details from the story or the plot line (concrete level) or with inferences from the story but not the theme (transitional level). It was hypothesized that the teacher ratings of all 49 students would accurately predict the cognitive functioning of each student's written response in language and literature.

The results indicate that the teacher was fairly accurate in predicting the students who functioned at concrete and transitional levels. A discrepancy occurred at the formal level where the teacher predicted 31 percent would be at formal level but only 6 percent of the students were actually at formal level. (See Chart 1)

CHART 1
Comparison Between Teacher Predicted Cognitive Levels and Actual Cognitive Levels of 7th Grade Students

	Teacher Predicted	Actual
Concrete	40% 19/49	51% 25/49
Formal	29% 14/49	41% 20/49
Transition	31% 15/49	6% 3/49

N=49 (1/49 was at preoperational level)

Question 2

The Joyce/Ankeny paper and pencil test for assessing the concrete operational stage was also given to all students. The Joyce/Ankeny was compared to the short story evaluation results. The results raise the question as to whether or not a math/science test of cognitive level can apply to all content areas including language and literature. A trend toward conflicting data was noticed between the two content measures indicating for example that a student who is operating at the concrete level in one subject may very well be at the formal level in another subject area.

Question 3

Assessment of cognitive levels of students in each subject area appears to be crucial, but only if some instructional change will then occur. As stated earlier, the best instructional environment appears to be one that does not separate students into discrete groups but rather one that integrates responses from students functioning at different cognitive levels.

Such an instructional environment appears to be created through the use of Herber's Three Level Study Guide approach. In this method the teacher reads the material to devise a series of statements that reflect three levels of comprehension: literal, interpretive, and applied. The researchers equated these levels with cognitive levels in the following manner:

literal level of comprehension—concrete cognitive level
interpretive level of comprehension—transitional cognitive level
applied level of comprehension—formal cognitive level

Before and/or after reading the material (in this study, a short story) small groups of students discuss each statement and attempt to support or refute it based on the information given in the selection and on their life experiences. The process is a group process with all members of each group expected to participate. Students are forced to think about and evaluate statements at each level of comprehension (and at several cognitive levels). However, students are free to respond only at the level(s) where they are comfortable, but at the same time they are exposed to the thinking of other students who may function cognitively above or below them. For example, student A may

function at the concrete level and therefore be very capable of participating in discussions of statements at the literal level, but he may not be able to contribute much to discussions of statements at the interpretive and applied levels of comprehension. He is, however, forced by the group process to listen to his peers who are at the formal level of thought as they interact with the statements and concepts. This exposure is important so that when he is again at a brain growth spurt, and therefore ready to move to the next cognitive level, he has had some experience with that level and can begin participation at that level.

In order to evaluate the actual effectiveness of this instructional method the researchers introduced the method into one class and did not use it in the second class. Four additional short stories were read by each class over a seven-week period. The first class read the story, then broke into arbitrarily set groups of 4-5 students each to discuss a series of statements about each story at each of the three levels of comprehension, and then individually completed the request to write the theme of the story. The second group merely followed the pretest procedure: read the story and wrote a response to theme.

The results of the Herber Three Level Study Guide instructional intervention did not seem to show any effects on students initially, but several critical factors had been ignored. The most important was in the actual eveluation process itself. The greatest value of the Guide was in the oral discussion it provoked, yet students were only evaluated on their cognitive performance on a written task that followed the discussion. Children in the seventh grade typically express themselves much better orally than in writing, so the evaluation process was inappropriately focused.

A second factor was that of time and instruction. The Three Level Study Guide is a sophisticated instructional method that is dependent to some extent on students' ability to interact as a group. The group that received the Three Level Study Guide instructional intervention had not had much instruction in group work, nor any previous exposure to this method. It is speculated that because of these factors and because only four short story guides were used, the students did not have enough time to use the Three Level Study Guide effectively.

Directions for Future Research

The present paper/pencil tests to measure cognitive level seem inadequate in predicting a student's cognitive level accurately in each content area. Piaget himself suggested that to test the cognitive level of a person accurately it is best to test a person in the field that is relevant to his career and interest.[6]

Many alternatives present themselves, including teacher-developed criteria and paper/pencil tests in each content area. Both were explored in this study with some rudimentary success, but each needs much more careful study.

Actual methods of instruction used in each content area also need to be examined. In a number of cases methods will have to be adapted or changed altogether in order to accommodate the range of cognitive levels in any class. Herber's Three Level Study Guide approach would seem to hold much promise if some prerequisites are met: instruction in the group process itself and specific instruction in the Three Level Study Guide. Individual students' oral responses during the discussions precipitated by the guide also need to be monitored carefully in order to observe each student's present cognitive level in relationship to literature and also any changes over the course of the year.

References

[1]For purposes of brevity and clarity, the term middle school will refer to all schools for the pre- and early adolescent.

[2]Epstein, Herman T. Summary of information presented to the 1977 National Middle School Association Annual Convention, Denver, Colorado, November, 1977.

[3]Epstein, Herman T., Conrad Toepfer and Bambii R. Abelson. *Brain Research in Transescent Education*, 1978.

[4]Sund, Robert B. *Piaget for Educators*. Columbus, Ohio: Charles E. Merrill Publishing Company. 1976. (Both tests are included in this book.)

[5]Herber, Harold. *Teaching Reading in Content Areas*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.

[6]Piaget, Jean. Intellectual Evaluation from Adolescent to Adulthood, *Human Development*, 15:1-12, 1972.

Piaget and Middle School Teaching

William D. Popejoy

In this paper, a brief summary of the psychology of Jean Piaget will be presented as it pertains to the middle school. Implications will be given for middle school teaching, evaluation, and curriculum development.

Piaget—The Developmental Tradition. Piaget (now 83 years of age) has been studying children for over 50 years. He has found that all children go through three stages of mental development:

Stage Name	*Approximate Ages*
Pre-Operational	Birth to 6 or 6 1/2
Concrete-Operational	6 or 6 1/2 to 12 or 13
Formal-Operational	12 or 13 to 18

Readers who are not well-informed about the concrete-operational and formal-operational stages are urged to read some introductory account such as *Piaget for Educators* by Robert B. Sund, Charles E. Merrill, 1976. During the concrete and formal stages, certain mental capabilities develop which he calls "operations."

Mental Operations. At the heart of Piaget's theory is the concept of "operations." During the concrete-operational stage, children become able to reason logically about "concrete" or real experiences they have had. They don't consistently reason correctly about abstractions, verbal propositions, or experiences they have never had. The "late" concrete child becomes good at reasoning by induction (drawing generalizations from several specific instances) but reasons badly by deduction. Most children of middle school age will be somewhere in Piaget's concrete-operational stage, with a few entering the formal-operational stage.

Piaget tests for the presence, or absence, of mental operations by using very clever interview situations. It is easy to interview for "concrete" operations—it is difficult and time-consuming to interview for "formal" operations. For this reason, there have been attempts to construct paper and pencil group tests to assess degree of "formality."

Development of the Burney Test. One of my students, Gil Burney, developed a good test which is being widely used all over the world. The Burney test samples four types of formal reasoning abilities:

1. Propositional Logic (7 questions)
2. Proportional Reasoning (5 questions)
3. Syllogistic Reasoning (3 questions)
4. Analogical Reasoning (6 questions)

There are 21 questions. A score of 15-21 indicates formal level, 10-14 transitional to formal, and 0-9 pre-formal. A copy of the Burney test appears in the Sund book. In several as yet unpublished studies, using the Burney test, we have found that no more than 10 percent of sixth, seventh, or eighth graders are formal. However, about 20 percent of the sixth graders and 40 percent of eighth graders are transitional to formal. Epstein (elsewhere in this publication) reports much lower percents. By whatever means used to

---

William Popejoy is Professor of Mathematics, University of Northern Colorado, Greeley, Colorado.

determine formality, it appears that *few middle school children are formal*, but it does appear that during the later years of middle school, early formal operations begin to develop.

How Mental Operations Develop. According to Piaget, four factors influence the development of mental operations: (1) biological maturation; (2) experience, both physical and logical-mathematical; (3) social interaction; and (4) equilibration—Piaget's explanation of how the new ability becomes available in the brain.

There seems to be a biological maturation factor working that is age-related. Only the very brightest children show formal-operational abilities by age 11. Most children are 12 or 13 before formal reasoning becomes available to them. It is interesting to note that at about ages 11-13, children begin to develop formal reasoning ability and that, according to Epstein, at the same age, a brain growth "spurt" occurs.

Experience is necessary for mental operations to develop. For example, children's experiences on a teeter-totter lead to the later development of proportional reasoning.

Social interaction provides the breeding ground for development of new mental abilities. Children learn that others think differently, see things differently, and have different beliefs. "Cognitive dissonance" is very necessary to mental growth.

Recommendations for Middle School Teaching

For Teaching:

1. Try to provide for discovery learning.
2. Ask divergent questions.
3. Watch your wait time after asking a divergent question. Children at the concrete level require more time than most realize to formulate answers.
4. Become a good listener. Talk less—listen more.
5. Provide group activities—allow for social interaction. Try to place children of different ages in each group with children of differing cognitive levels.
6. Select your instructional materials with cognitive level in mind. Remember, most of your students are operating at the concrete level.
7. Don't be fooled by mature language, which is not necessarily a sign of formality. Listen to the thinking involved.

For Evaluation:

1. Consider a child's cognitive level. Don't expect children at lower levels to compete with children at higher levels. A student should not be made to feel inadequate simply because he is operating at a lower cognitive level than others.
2. Remember that the process of "right thinking" is often more important than "getting the right answer." Listen to the thought processes of children.

For Curriculum Development:

1. Include only material that can be presented concretely.
2. For those few formal thinkers, provide enrichment activities that will enhance their cognitive development.
3. Include less. Concrete thinkers need more time than most think to internalize what we teach. *Go slower!*
4. Now, more than ever before, it is important that we teach children how to learn—how to think. Provide in your curriculum "learning how to learn—learning how to think" activities.

As Galileo is credited with saying, we cannot teach another person anything. We can only help him to discover it for himself. And that is what teaching is all about—helping others to discover for themselves worthwhile things they might not otherwise have discovered.

Comments on a Two-dimensional View of Cognitive Ability

Rex R. Schweers, Jr.

Considerable research is currently being conducted and reported on that attempt to relate cognitive ability, in a Piagetian sense, to factors of child development such as brain growth, language acquisition and use, and reasoning patterns applied to various disciplines. Epstein has done considerable work with brain growth and has reported (1977) on a linkage between brain growth stages and Piagetian stages of cognitive development with implications for middle school curriculum development. Renner has examined the possibility of using a student's expressive language in response to particular problem incidents to determine the student's level of intellectual development (with the conclusion that such predictions could not be made). Applications of Piaget's theory and students' reasoning patterns to science teaching have been presented by Karplus (1977). These and other studies add to our knowledge of how students learn and should be beneficial to the development of appropriate school curriculum.

To facilitate study of cognitive-related factors and to clarify and expand the classification scheme for cognitive development, Schweers, Popejoy, and Pavlik reported in 1979 on a proposed two-dimensional view of cognitive ability. Following are some comments on observations relative to that report.

The proposed two-dimensional view of cognition was an effort to assign a scale to the Piagetian cognitive continuun. The scale was derived by plotting the results from two paper-and-pencil reasoning tests on a rectangular grid. The tests were: (1) The "Reasoning Test", developed in 1974 by Ankney and Joyce, containing 30 multiple-choice items assessing concrete reasoning; and (2) The "Logical Reasoning Test," developed in 1974 by Burney, containing 24 multiple-choice items assessing formal reasoning. The population for this report consisted of 160 students in grades 8, 10, and 12 in a public school system in an eastern Colorado community. For a more detailed account of the tests and population and for an analysis of the development of the scale, see Schweers et al., 1979. Figure 1 presents, in rectangular fashion, the intervals established and the frequency distribution of scores on the two tests. The intersections of the intervals on the two axes form modules each of which is identified in Figure 1 by a pair of capital letters. Modules along the diagonal from cell BA to cell FE, containing the boldface type numerals 7 through 15, constitute the scale to which reference is previously made. The cells, referred to as the PCM (Primary Cognition Modules), encompass the cognitive continuum from early concrete to late formal levels; they contain 75 percent of the population tested.

Subjects in specific PCM demonstrate some commonalities in responses to items on the two "reasoning" instruments. Tasks that individuals in each cell are able to perform and a general tendency for incorrect responses on tasks can be identified. These tendencies will be the subject of a future report. Suffice it to say here that such information could be quite useful in

Rex Schweers is Associate Professor of Mathematics, University of Northern Colorado, Greeley, Colorado.

attempting to mesh the identified cognitive skills mastered by an individual with appropriate content, language level, and learning and teaching styles.

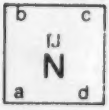
In Figure 1, a tendency for linearity in the plot of scores is apparent, specifically along the diagonal of the PCM. A regression analysis using the linear regression model yields an interesting relationship when computed for each of the grades tested. With X representing a score on the Formal test and Y representing a score on the Concrete test, the equations of the regression lines and corresponding correlation coefficients, computed for ungrouped data, are presented in Table 1. The low correlation coefficients for each grade and for the total population might be disappointing considering that both tests measure cognitive ability. However, the two tests are designed with

Figure 1. Bivariate frequency distribution of scores on the concrete and formal tests showing the primary cognition modules (PCM).

CONCRETE	0-5	6-9	10-14	15-18	19-21
27-30	0 0 FA 0 0	0 1 FB 2 3	5 2 FC 3 10	7 6 FD **14** 2 15	1 7 FE **15** 0 8
23-26	0 0 EA 1 1	2 0 EB 5 7	13 7 EC **12** 13 33	18 8 ED **13** 2 28	2 1 EE 0 3
19-22	0 0 DA 3 3	2 3 DB **10** 9 14	2 4 DC **11** 7 13	3 1 DD 0 4	DE
15-18	0 0 CA **8** 3 3	1 0 CB **9** 5 6	1 1 CC 2 4	1 0 CD 0 1	CE
11-14	BA **7**	0 0 BB 2 2	BC	BD	BE
0-10	0 0 AA 1 1	AB	0 1 AC 0 1	AD	AE

FORMAL

Code



where:

[J names the cell;
a, b, c, d are cell frequencies,
a for 8th grade,
b for 10th grade
c for 12th grade,
d = a + b + c;
N is a PCM number.

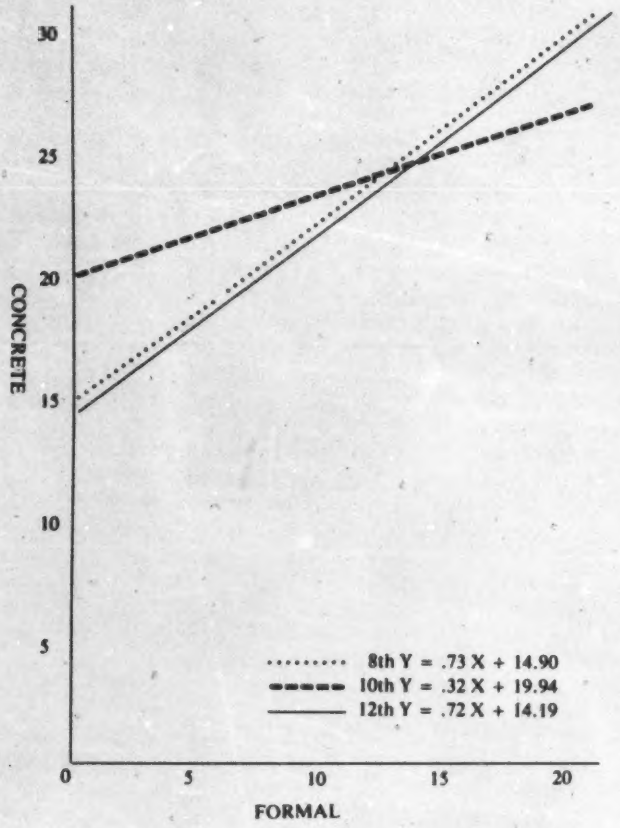
tasks directed to *different* cognitive levels: The concrete tasks are directed to concrete operations and the formal tasks to formal operations. Considering previous research on the subject, one should be more surprised and/or disappointed if the correlation coefficients were high; such an occurrence would suggest that the two tests do not measure different things and would make them suspect as measuring instruments in view of their purported design. That the correlation coefficients are as high as they are, along with the general shape of the distribution of scores might suggest that individuals may use formal reasoning patterns without first being fully concrete operational. (This condition is contrary to beliefs held by some Piagetian researchers but is supported by others.) The pattern of this curve might also be explained by the fact that students' reasoning patterns are not employed consistently. Karplus, writing on the status of the theory of formal thought and applications to science teaching, reports such occurrences (Karplus, 1977). It is *likely* that individuals use reasoning patterns only sufficiently sophisticated to resolve the situation—perhaps ones with which they feel most confortable; thus, they resort to patterns at a level lower than that of which they are fully capable. It is also possible that an individual does not function mentally at the same level as that which he/she employs in language-based communications.

The real surprise with the correlation coefficients in Table I lies in the wide variability by grade level. More striking is the difference in the regression line equations for each grade level, the graphs of which appear in Figure 2. While the graphs of the lines for grades 8 and 12 are almost identical, the graph of the line for grade 10 is significantly different, both in slope and y-intercept. This variability bears a remarkable similarity with Epstein's *brain growth stages*. Epstein infers "that brain growth spurts are correlated with mental growth spurts which signal novel intellectual competencies" (Epstein, 1977, page 8) and further infers a relationship between these stages and the stages of Piagetian cognitive development. He reports a spurt in brain and mind growth around the period of ages from 14 to 16 years with a peak at approximately age 15. He also reports periods of slow brain and mind growth during the periods of ages 12 to 14 and 16 to 18 with low points of development at about ages 13 and 17 years, respectively. The mean ages (m) and age ranges (R), in years, for the subjects represented in the curves in Figure 2 are as follows: Grade 8—m: 13.9, R: 13.1-15.2; grade 10—m: 15.8, R: 14.9-16.7; and grade 12—m: 17.9, R: 17.3-18.7. Because of the close agreement in ages of the subjects of the reports of Epstein and Schweers et al., it is inferred here that the flatness of the grade 10 curve, compared to the curves of grades 8 and 12 (Figure 2), reflects a brain growth spurt for the tenth graders of this population. Further, the mean score of the grade 10 subjects on the Burney instrument was 14.5 (where scores from 10 to 15 denote Transitional to Formal by the Burney criteria for measure of formal operations (Burney, 1974).) Thus, the grade 10 subjects are, in general, in a

TABLE I. Summary of regression analysis relating concrete scores (Y) to formal scores (X), computed for ungrouped data.

Grade	*n*	*Regression Line*	*Correlation Coefficient*
8	60	Y = .73x + 14.90	.57
10	58	Y = .32x + 19.94	.36
12	42	Y = .72x + 14.19	.63
Total	160	Y = .58x + 16.20	.62

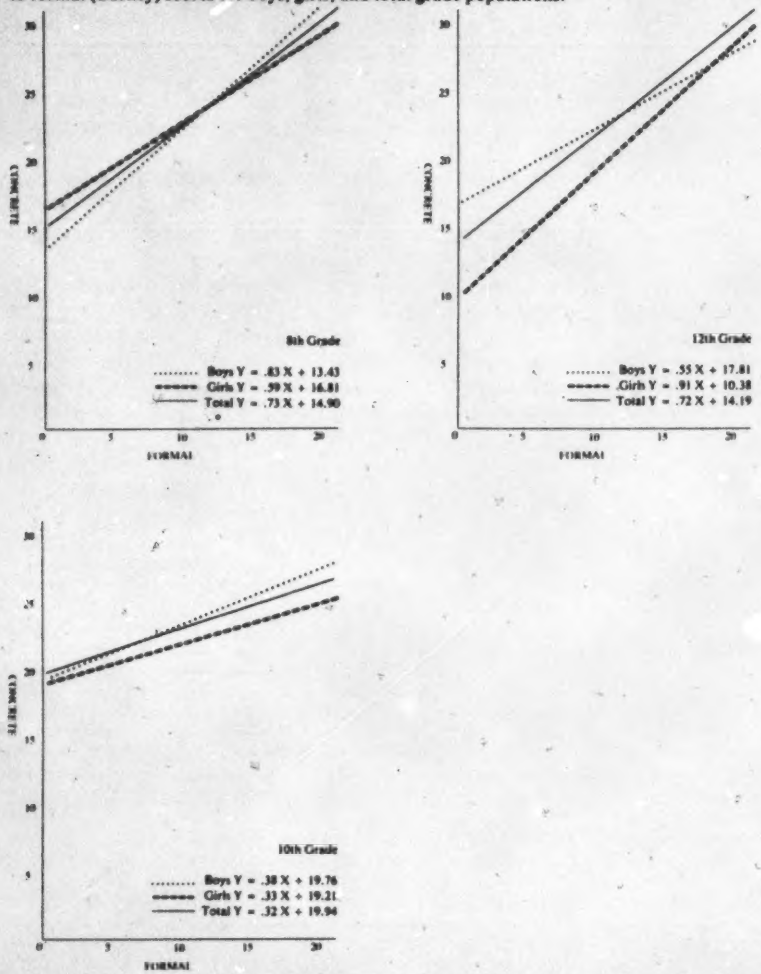
Figure 2. Graphs of the regression lines relating concrete (Ankney-Joyce) scores to formal (Burney) scores for grades 8, 10, and 12.



period of growth to the attainment of formal operations. A similar inference relative to brain growth and cognitive development can be made for the subjects in grades 8 and 12. These subjects appear, in general, to be in periods of slow brain and mind growth. The grade 8 mean Burney score was 9.2 indicating, by the Burney criteria that in general, the subjects are operating at a Pre-Formal level. It should be noted that not all of these subjects are fully concrete operational so it should not be concluded that operation at a Pre-Formal level means operation at the Concrete level. It should also be noted that some of the grade 8 subjects demonstrated use of formal operations. The grade 12 mean Burney score was 15.0 indicating, in general, extensive use of formal operations according to the Burney criteria.

Confirmation of the above inferences will be attempted by further testing of two types. First, the grade 8 and 10 subjects will be tested two years hence, to see if their stage development by age and grade conforms to that previously established. Second, the same testing will be conducted with a larger and distinctly different population to see whether or not their stage development conforms to that previously established.

Figure 3a, b, c. Graphs, by grade, of the regression lines relating concrete (Ankney-Joyce) scores to formal (Burney) scores for boys, girls, and total grade populations.


8th Grade
Boys Y = .83 X + 13.43
Girls Y = .59 X + 16.81
Total Y = .73 X + 14.90
12th Grade
Boys Y = .55 X + 17.81
Girls Y = .91 X + 10.38
Total Y = .72 X + 14.19
10th Grade
Boys Y = .38 X + 19.76
Girls Y = .33 X + 19.21
Total Y = .32 X + 19.94
FORMAL

It is interesting that other researchers have reported a slowing of intellectual development at stages and ages similar to those reported here and by Epstein. In a study of British subjects, Shayer (1978) reports such a slowing for girls around age 14 years and about a year later for boys. Although the subjects and the techniques of evaluation of the Shayer study are different from those that are reported here, the girl-boy differential in intellectual development may be inferred from the data on which this report is based. Figure 3a presents the graphs of the linear regression equations for grade 8, computed separately for boys and girls; it also presents the graph for the total grade 8 population. Similar presentations are made in Figures 3b and 3c for grades 10 and 12, respectively. In the presentation for grade 8 (Figure 3a), the slope of the regression line is greater for the girls than for the boys; although not as marked, the same is true for grade 10 (Figure 3b). That the grade 8 subjects appear to be in a period of slow development and that the

grade 8 mean age is approximately 14 years seems to conform to the Shayer results of a slowing of intellectual development at about age 14 to 15 years. Whether or not the girls have preceded the boys into this stage of slow development (or perhaps have begun to progress into the next stage of development—a spurt) cannot be inferred at this time. That a girl-boy difference in development exists is apparent. The variability in slopes, particularly the wide differences at grades 8 and 12, provides interesting speculation and suggests an area for further study.

The significance of the above comments on the two-dimensional view of cognitive ability is this: The comments seem to this writer to reinforce inferences and recommendations made by other researchers referenced in this article. The testing instruments, the evaluation procedures, and the resulting two-dimensional view of cognitive ability (PCM) may contribute to a quick, easy method for identifying brain and mind growth stages and the identification of individual differences in cognitive development. The implications of potential for impact on curriculum development, school programs, and even teacher preparation programs are themselves significant and far-reaching. Much research—long-term research—needs to be done to determine the effect and effectiveness of such considerations.

References

Ankney, Paul and Lyle Joyce. The Development of a Piagetian Paper and Pencil Test for Assessing Concrete Operational Reasoning. Dissertation for Ed.D., University of Northern Colorado, 1974.

Burney, Gilbert M. The Construction and Validation of an Objective Formal Reasoning Instrument. Dissertation for Ed.D., University of Northern Colorado, 1974.

Epstein, Herman T. A Neuroscience Framework for Restructuring Middle School Curricula. *Transescence: The Journal of Emerging Adolescent Education:* Vol. 5, 1977, pp. 6-11.

Karplus, Robert. Science Teaching and the Development of Reasoning. *Journal of Research in Science Teaching:* Vol. 14, No. 2, 1977, pp. 169-175.

Renner, John W. Assisted by Dianna K. Prickett and Michael J. Renner. Evaluating Intellectual Development using Written Responses to Selected Science Problems. A Report to the National Science Foundation on Grant Number EPP75-19596, "Anaiysis of Cognitive Processes."

Schweers, Rex R., Jr., William D. Popejoy, and Robert A. Pavlik. A Proposed Two-Dimensional Scale for Cognition. *Colorado Journal of Educational Research:* Vol. 18, No. 3, 1979, pp. 17-22.

Shayer, Michael. The Distribution of Piagetian Stages of Thinking in British Middle and Secondary School Children. II—14- to 16 Year-Olds and Sex Differentials. *British Journal of Educational Psychology:* Vol. 48, 1978, pp. 62-70.